Carpet Manufacture

BY

Fred Bradbury.

DESIGNING
& COLOURING
BRUSSELS
WILTON
TAPESTRY
AXMINSTER
CHENILLE AND
RUGS & SQUARES
INGRAIN SCOTCH
AND
KIDDERMINSTER

ree 162

K6108 12.50
TECHNOLOGY

Edwin J.

CARPET MANUFACTURE.

PRINTED BY

F. KING & SONS, LTD., BROAD STREET,

HALIFAX.

Carpet Manufacture

BY

FRED BRADBURY,

HEAD MASTER TEXTILE DEPARTMENT, MUNICIPAL TECHNICAL INSTITUTE,
BELFAST.

EIGHT YEARS HEAD MASTER, TEXTILE DEPARTMENT, MUNICIPAL
TECHNICAL SCHOOLS, HALIFAX.

DH

Author and Publisher,
Langdale House, or Municipal Technical Institute,
Belfast, Ireland.

AGENTS:
Messrs. Lord and Nagle Company,
299, Devonshire Street, Boston, Mass., U.S.A.

1904

PREFACE.

It is perhaps in the order of fitness, that the first and most comprehensive treatise on "Carpet Manufacture"—embracing as this does Designing, Colouring and Weaving of Brussels, Wilton, Tapestry, Axminsters and Ingrains—should emanate from such a great carpet manufacturing centre as Halifax.

Hitherto this subject has received, in comparison with its importance, far less attention than any of its contemporary woven products, for whilst many excellent literary works have appeared dealing with other branches of the Textile trades, the 'Carpet Industry' has been left severely alone. Hence this work is issued to supply the deficiency and may therefore claim to be unique and distinct in character.

Many friends and carpet manufacturers have encouraged me by their assurance of the necessity for such a book, and the splendid success which my former publication "Calculations in Yarns and Fabrics," has achieved further encouraged me to press forward with this work.

The present treatise has been carefully prepared from notes and observations made since 1896 when I first conceived the idea of such a publication. No mental energy nor material expense has been spared to make it as complete as possible. I have come into practical touch with almost every detail of machinery described within these pages; the illustrations too, are almost all selected from machinery in present use.

The carpet and rug patterns on the plates have been designed and woven under my supervision at the Municipal Technical Schools, Halifax.

The principal divisions of each chapter are arranged with a headline across the page and the sub-divisions in bold type at the top of their own particular paragraph for convenience and ready reference.

My thanks are due to many friends in Halifax and other parts of the country who have read the proofs and offered suggestions, and to the printers Messrs. F. King & Sons, Ltd., and the block-makers, Messrs. Blatchford Bros., who have executed the work entrusted to them most creditably.

The supreme desire of the writer is that a perusal of the book will afford much pleasure, interest and instruction to the reader and student alike.

F. B.

Halifax,
October, 1904.

Contents.

CHAPTER I.

Designing.

CHAPTER II.

Colour.

CHAPTER III.

Brussels Carpets.

List of Illustrations.

COLOURED PLATES.

HALF TONES.

LIST OF ILLUSTRATIONS.

(Continued.)

— *PRESS OPINIONS.* —

ON

"Calculations in Yarns and Fabrics."

The "TEXTILE RECORDER":—

"This volume is one of the modern type of books on textile calculations, not merely giving a few simple rules, but fully explaining the facts upon which they are based........*is the most complete book of that sort we have seen........ The book is very clear.*"

The "MANCHESTER GUARDIAN":—

"....An interesting and useful chapter is devoted to the testing of textile materials and the standard allowance for moisture in each kind........Mr. Bradbury's book supplies a kind of information useful to textile manufacturers which, so far as we know, has not been published in anything like the abundance presented in his 'Calculations'."

The "TEXTILE MERCURY":—

"....The volume contains an abundance of useful information, and should be in the possession of students, teachers, managers, and all persons having to deal with the matters of which it treats."

The "GLASGOW HERALD":—

"....a book which embodies knowledge and experience....and which will prove of great service to the spinner and manufacturer of textile materials."

The "NEW YORK COMMERCIAL":—

"....A most excellent work."

The "YORKSHIRE DAILY OBSERVER":—

"Mr. Bradbury, who is well known in the West Riding......now makes a valuable contribution to the literature on textile subjects. In handy form, though with minute detail, he enters into the various systems of counting yarns, and *the whole field of calculations, for costs, weights, and all technical purposes, is carefully traversed.* The work is divided into twelve chapters, each of which treats on some different system connected with the subject. After analysing and explaining the system in a manner which is easily understood, the author enforces his lessons by a number of examples and tables. At the end of each chapter space is devoted to exercises in the form of questions to which answers are given. By this means the student will be able to test his knowledge as he goes on. It is impossible to give an epitome of the whole book, but a few extracts from one chapter will give an idea of the way in which every branch of the subject is treated. In the chapter dealing with 'The Weight and Cost of Woven Fabrics,' details are given full of interest, especially to those who look forward to a manufacturing career, and also to merchants engaged in the sale of textile fabrics......"

CHAPTER I.

Designing.

Introductory Notes.

Carpets belong to the class of woven fabrics where many distinctive qualities of decorative art may be displayed.

But in addition to the possession of any artistic ability the designer of such woven structures should receive a thorough technical training before he can expect to merit commercial success. When he is conversant with the trade requirements and sufficiently considers the subsequent surroundings and associations which his productions are expected to meet, he will be able to know exactly how to select and adapt his ornament to satisfy the conditions of the structure of the carpet, the capacity and limitations of the mechanism and the fitness of environment.

Admittedly, many designers for carpets are deficient in technical knowledge, requirements, capacities, possibilities and limitations, which govern the work to be done. Through this lack of knowledge they fail to reach the standard of excellence in design and colour attained by many of their contemporaries.

It is only just to say that the structure of a carpet is not by any means so complicated as to forbid any person of average ability from readily and thoroughly comprehending it. Given this information the pleasure of designing will increase, for then the student will be working not so much by rule as from knowledge. Further, increased technical ability added to artistic taste, natural or acquired, will impart freshness and freeness to both form and colour in any woven pattern. Still further, since the mechanical reproduction of designs and colour schemes, good, bad and indifferent, is virtually the same in woven fabrics, the extra cost in employing superior designers and colourists is comparatively small where the goods are manufactured in anything like quantities. It is therefore increasingly evident, that the submission of a superior article at

such a small increase of cost, becomes primarily an inducement to favour, choice and purchase.

General Improvement in taste.

It should be the aim of all true citizens and friends of art to endeavour and to encourage every effort to improve the general taste. There are two ways of accomplishing this object. (1) Directly—by teaching; (2) Indirectly—by the preparation and submission to buyers and users, of patterns which accord with reason and general approval of that which is good.

The former method in many respects is the shorter and better, but since it involves effort on the part of the many it is necessary meanwhile to rely on the latter.

The designers in particular and producers in general, should themselves be afforded every opportunity of training in both art and technique and surrounded by an atmosphere conducive to refinement of taste. Their repeated productions under such conditions will then gradually and passively, though imperceptibly but assuredly, provoke in the general mass of purchasers and users a growing sense for the beautiful.

Influence of the Commercial Standard.

The commercial standard is the chief factor which influences the productions of the modern manufacturer, since the merchant, factor or dealer practically dictates what must be made. He in turn is governed somewhat by the tastes and inclinations of his customers, therefore the dealer only orders and the maker only produces the class of goods which experience teaches them 'will sell.' Nevertheless the designer and manufacturer should and often do, to their credit be it said, make samples and submit at every opportunity designs and colourings which are artistically superior to many carpets hitherto produced.

Progress in Taste.

Under such conditions progress is necessarily slow, yet the observing student of applied art, in in its relation to woven structures, cannot fail to see that the character of design and colour has changed for the better within the last 20 years. The credit for this advance is partly due to the improved training given to designers

and the increased facilities for the study of art and technology. The small rooms and cramped accommodation in mechanics' institutes and similar buildings (good in their way) of 20 years ago, have given place to the commodious Technical Schools with spacious art rooms and corridors decorated with the best designs of past masters and modern art. The same truth applies to many of our Textile Departments. Briefly summarised then, the present day student moves in an atmosphere which is calculated to encourage and inspire him to resolve, not only to equal, but surpass if possible the selected examples which daily surround him.

As a result of these increased facilities, woven designs possessing superior artistic properties and better schemes of colouring are submitted each succeeding season to the purchasing public. Further, many of the choicest designs which have been made in higher grade textures are repeatedly reproduced in cheaper materials and structures—fine grade Axminsters which are often reproduced in Tapestries being examples to wit.

Artistic Development Retarded.

There are factors, however, which operate in a contrary direction, and so contribute in retarding the makers' enthusiasm for improved art, and here are two examples of many which could be cited in support of this assertion.

First, manufacturers frequently experience much difficulty in obtaining a higher price for really good designs than for those artistically inferior, when both are woven in corresponding qualities of material and of the same structure.

Second, the frequent changes in fashion make it almost impossible for a pattern to last for more than a year or two, hence the manufacturer must secure orders for considerable quantities in order to enable him to pay the price for really good designs.

Advantage of Oriental over Modern Carpets.

It is here that the Eastern carpets possess an advantage over their machine made competitors. The oriental rule is reproduction, consequently its patterns are slow of growth. The designs pass from weaver to weaver receiving various modifications by the way and the best being most prized have survived to

the present time. In this sense such patterns are a survival of the fittest, many of them being examples of what a perfect carpet should be both as regards form and colour. At the same time, there are many examples of so called Eastern carpets which are poor in design and crude in colour. The only merit they possess lies in the name they bear. One cannot help feeling convinced that in some respects many oriental weavers of the present day live considerably on the momentum of their ancestors. In addition, many imitators trade on the '*name*.'

Present day Requirements.

Then, though there is much room left for improvement in the general taste, no maker can afford to permit his looms to remain idle until his customers are sufficiently educated in chromatics and design as to appreciate and purchase the best and choicest productions. Meanwhile, he must stow away his own ideals and be content to study their requirements, conditions and tastes and endeavour to satisfy them.

Principal Classes of Carpet Design.

There are three chief classes of design in carpets and general floor decorations.

I. Those which have a purely geometrical basis of construction and ornament.

II. The conventional treatment of natural forms.

III. Reproductions and imitations of former designs and masterpieces.

Geometrical Class of Designs.

The first class of designs comprises those used for linoleums, oilcloths, and some of the cheaper kinds of carpets. Such patterns are evolved, rather than constructed; they are the result of interchange of squares and rectangles, divisions of circles and radiating lines. The geometrical principle is essential for all repeating designs and it is in this sense that all really good ornament may be said to have a geometric base, but this does not necessarily imply that the ornament itself must be geometrical.

Conventional Treatment of Natural Forms.

In this class of ornament natural forms are first studied in minute detail, then conventionalised to suit some specific purpose and make of fabric; or, expressed more tersely, the designer voluntarily first becomes the slave of his selection and then in turn he reverses this order by making it conform to his wishes. At the same time he emphasises such natural features of the subject as are best suited to his purpose. The design must be conventionally treated in its entirety, and not one part conventionally, and another naturally rendered. Plants and flowers must be displayed flat to a symmetrical arrangement and even animals and birds, when used as ornament, should be reduced to their simplest flat forms. Natural objects should be represented their normal size or greatly diminished. If they are portrayed larger the inevitable effect is poor, if only slightly reduced the pattern is generally meagre and weak, but if the reduction is great it is so obvious that it is impossible to mislead. Lastly, interest will always be added when the natural subject can be detected.

There has been a tendency during recent years to elevate all who are attempting originality in decoration by going direct to nature and conventionalising her forms and while there is much that is commendable in this method, historical and past standards cannot wisely be neglected.

Reproductions and Imitations of former designs and masterpieces.

The selection and study of historical works of applied art, particularly those of Eastern and Indian origin, are either reproduced or modified and adapted to suit modern requirements.

Such examples of past productions and all masterpieces ought to be studied, not with any view to a slavish reproduction, but for the purpose of inspiration and to catch the spirit which dominated them. A study of oriental carpets on these lines will afford many a silent and valuable lesson in proportionate adjustment of figure and ground, in grouping of borders and of the general effect when produced. One frequently experiences very considerable personal pleasure besides many suggestive thoughts from an examination of historical woven tapestries or carpets of

recognised merit. Most things which are good and lasting have their foundations in the past. If then there be combined with a good modern training a clear knowledge of historic masterpieces, the production of designs, satisfactory both in form and structure would be ensured. An examination of such fabrics reveals the following facts: 'Construction' is decorated and decoration is never purposely constructed, and generally the basis of ornament and repeat of pattern are as far as possible eliminated from the design. In a relative sense a builder removes his scaffolding when the building is complete. Many designers, however, prefer to emphasise the basis of their ornament. It is much easier to produce a pattern where the structural basis is evident than to conceal its framework. Elimination of foundation lines is subtle and difficult. It involves much thought and many people find it hard work to think. Again, it is found that 'Beauty of Form' is produced by lines growing out of the ornament; there is an absence of want in the design—neither removals nor additions are felt to be necessary. The general form receives the first consideration, next follows the principal flowing lines which give stability and grace to the design, and finally the chief ornament is added. Yet, one other observation—let us take a peep into the architect's note book. It is filled with sketches of details, copied from great works and examples of architecture which have survived time and decay. When plans are prepared, frequent references are made to this sketch book and the details contained therein are studied until the architect becomes imbued with the spirit characteristic of the originals. Such initiative and individual feeling toned by the influence of past art will always result in good decoration.

There is much that is meritorious in both the second and third classes of carpet designs, but a slavish following of either is fraught with danger and disadvantages chiefly owing to the limitations which the adoption of either method separately imposes. If the former be rigidly followed and the latter ignored it involves a constant struggle with first principles, whereas if the order be reversed, the so-called designer is neither more nor less than a copyist.

Machine Made Carpets.

Classification.

There are three chief classes of machine made carpets.

First, those in which the figuring is produced by the aid of a jacquard machine, the size of each repeat being limited to look up
the capacity of the figuring mechanism. To this class belong Brussels and Wilton of the pile sort, and Ingrain, Roman, Scotch or Kidder of the art squares and pileless carpets.

Second, those which are produced without the aid of a jacquard machine *e.g.* Chenille or Patent Axminster and Royal Axminster.

Third, those on which the pattern is either printed—literally painted on the pile yarn before being woven, or, after the carpet is woven, printed by hand blocks or machine driven cylinders. The former method is the more satisfactory and that most generally adopted, for the design and colour scheme is virtually limitless, but when blocks or cylinders are used the capacity of the design is limited to these. Belonging to this division the Tapestry is the most typical representative. 'Smyrna' carpets may also be included under the same heading.

General Possibilities.

At this stage, the chief possibilities and limitations of machine made carpets, might with advantage be briefly generalised. Later on, and in order, each class will be more fully considered.

The pattern in all machine made fabrics belongs to the *repeating* class. This mechanical repetition has the advantage of even distribution, balance and repose, though in some respects it is objectionable, for when carried too far it produces monotony. On the other hand, the carpets woven in hand looms particularly those from the Orient are unlimited and unfettered in variety of idea, design and colour and yet, even variety may be carried so far that it becomes impossible to fully appreciate it. When the predominant factors, balance of design and colour, are acquired in any woven pattern, it never tires the eye, either by too frequent repetition or intricate variety.

Eastern carpets are nevertheless more frequently preferred to those woven in power looms—the variety of pattern being the chief factor in their favour. This desire for 'variety' can be satisfied in machine made productions when the customer is prepared to pay the price as he is for those of oriental manufacture and its imitations.

Patterns can be schemed and produced in power looms of modern construction, which when repeated possess all the appearances of unit decoration, *i.e.* the repeat of the design is not very apparent and the eye is carried with interest over the complete filling as though it were a single repeat.

Such carpets are of better value and structure, and relatively much cheaper than those of Eastern make.

The limitations of design and colour should be considered a necessary part of the designer's craft, and he who overcomes them by thought and invention will add increased charm and interest to his woven patterns, whether of hand or power manufacture.

Repeating Patterns.

Repeating ornament may be designed so as to emphasise the repeat or conceal it. When the pattern is produced with a view of disguising the repeat, it possesses characteristics which belong to patterns of large repeat. In other words, a pattern is produced costing the minimum of expense but bearing the impress of the maximum. Any decided feature of line or ornament will emphasise the repeat, and tend to cause irritation, the absence of which constitutes one of the chief factors in a good design. It is usual to disguise all construction lines which, though they assist in giving grace, strength and stability to the ornament, should nevertheless be concealed or covered with pattern when the design is completed.

Testing the Repeat.

There are several methods in use for testing the qualities of a repeating pattern, viz. :—

1. The pattern may be run beyond the lines which bound the repeat and so ensure the correct fitting of top and bottom and side to side.

2. The design may be cut across the centre either vertically or

horizontally, and the top and bottom or sides joined in accordance with the cutting.

3. The paper on which the design is made may be so folded in either direction that the top and bottom or sides shall appear joined, when any defect can be easily detected.

Bases of Construction and Distribution of Repeating Patterns.

In this treatise no attempt is made to describe in minute detail the principles of design and designing, but rather to explain the technical side of the subject, which includes structure of fabric, possibilities and limitations of design and colour, principles of mechanism and methods of productions. Nevertheless it is essential that some thought should be given and space devoted to the basis and distribution of the ornament, without which this work would be incomplete.

In the arrangement of repeating pattern the chief systems in use are:—

1. Distribution of a unit figure on some elementary weave basis.
2. Simple or Whole Drop.
3. Reversed Simple Drop.
4. Half or Step Drop.
5. Half or Step Drop reversed.
6. Diamond or Lozenge.
7. Wave line.
8. Ogee—Various forms of.
9. All-over Pattern.
10. Multi-symmetry.
11. Borders and Squares, including Chlidemas.

Simple Patterns.

The design for carpets such as are used in churches and public institutions are generally of the simplest repeating kind. Any simple but graceful form is first selected and then distributed over the repeat area—(1) on some elementary weave or sateen basis;

(2) upon the simple or whole drop; or (3) upon the reverse drop principle.

The advantage of using a detached figure and repeating it over a given area is evidenced by the variety of directions in which each unit may be placed. This makes the complete pattern approach nearer the ideal floor decoration, for it appears more or less the same when viewed from any point. For Brussels or Wilton carpets this system lends itself admirably to *planting* purposes, since each unit figure may be separately and differently coloured in whole or part.

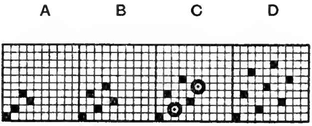


Fig. 1.

Distribution of unit figures on a weave basis.

Having first selected the unit figure the next thing is to determine the basis of distribution. Four of the most useful methods of arrangement are shown at A, B, C, D.—Fig. 1.

These are respectively and technically known as :—

The 4 end broken sateen.
,, 5 ,, perfect ,,
,, 6 ,, broken ,,
,, 8 ,, perfect ,,

The spaces between the longitudinal lines of the point paper represent the warp threads, called 'Ends,' and the spaces between the horizontal lines represent the weft threads, called 'Picks.'

Sateens are of two kinds, viz :—Perfect and Broken.

Perfect sateens are usually made by placing the warp or weft marks in the first square in the repeat area and then repeating this mark on each succeeding pick of weft, but moving it any number of ends which is not divisible into the number of threads in one repeat of pattern; hence upon five threads the 'pure' sateen is obtained by moving the warp or weft marks two or three ends at

each new pick, and upon eight threads three or five may be used as a basis ; similarly with any other number of threads.

Broken sateens have no definite order ; they have consequently to be schemed—four and six ends sateens are examples to wit—since there is no number from or below the half of four or six but what is a definite measure of those numbers. All numbers above the half are inversely as those below it. Figures arranged on this principle are necessarily distributed evenly.

The principal points which must be observed are :—(1) Upon the number of ends and picks used, the spots must lie equi-distant from each other. This is obtained by dividing the number of ends and picks into as many squares as there are spots in one repeat of the pattern, *e.g.* in a $\frac{3}{4}$ square of carpet containing 260 threads and wires : $260 \div 5 = 52$. *i.e.* Each square will equal 52 threads and 52 wires.

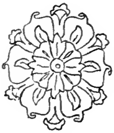


Fig. 4.

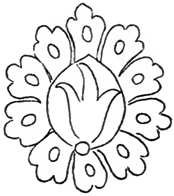


Fig 2.

Fig. 5.

Upon the first square draw the figure required and repeat it in a corresponding position in the next square to be used in sateen order, as illustrated at Figs. 2 and 3.

Fig. 2 represents the detached unit figure in outline.

Fig. 3 shows the same form distributed over the repeat area in five end sateen order, except the several parts of each are variously marked to show the number of colours which might be used. In this pattern each unit figure is turned $\frac{1}{5}$ about its centre so that when completed, the design appears the same from any point of view. The method whereby this is obtained consists in first finding the centre of the repeat area, then with this point as centre describe

a circle within the limits of the repeat and divide it into five equal parts as shown by the dotted lines. Then, when the central position of each figure has been determined so as to agree with the selected sateen basis, they are arranged relatively parallel with the five radial lines respectively.

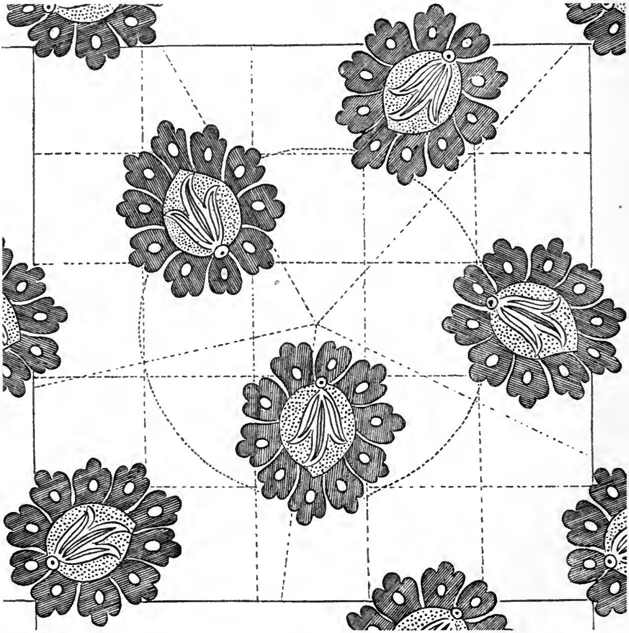


Fig. 3.

When the six end broken sateen is used as a basis, two unit figures may be selected or sketched (see figures 4 and 5) and placed thus:—Fig. 4 where the solid squares are shown, and Fig. 5 in positions which correspond to the circles in Fig. 1c. The completed

pattern is then dissimilar and possesses the distinct advantage of producing variety of idea. The principle is fully illustrated at Fig. 6, where the two unit figures are distributed and differently

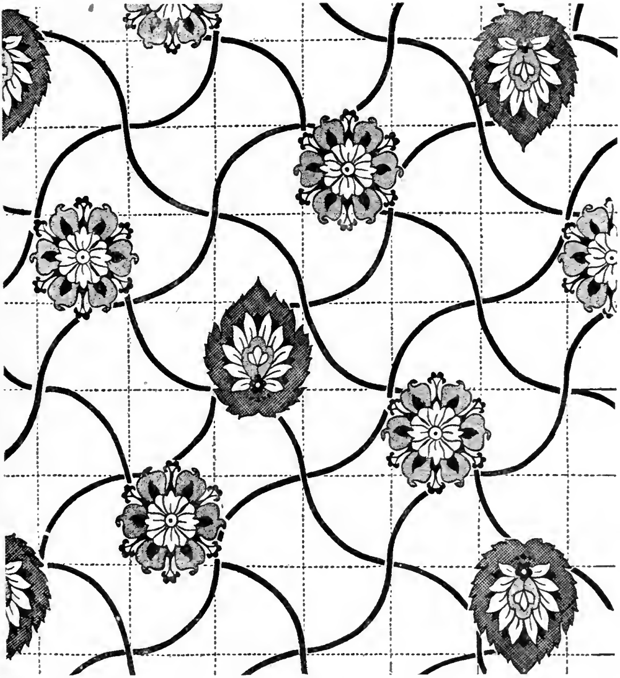


Fig. 6.

marked to represent the several colours used. Fig. 4 is displayed the same throughout, whereas Fig. 5 is dropped and set diametrically opposite.

Simple Drop.

This system of distribution is extensively used. It is very suitable for those fabrics where a considerable amount of ground is required to be seen, and where an interchange of two separate units of form is desirable. An illustration at Fig. 7 represents the simplest form of drop.

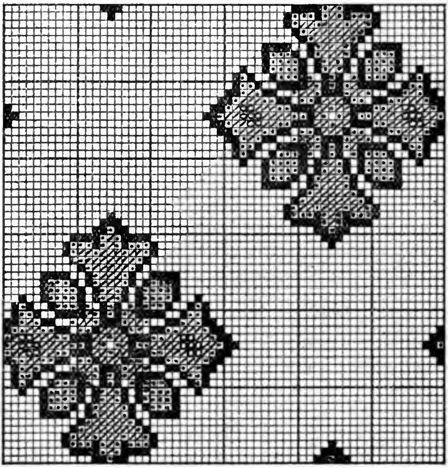


Fig. 7.

The term 'drop' as applied to design had its origin in the frequent use of a method employed by printers of wall papers, cotton fabrics and other printed materials.

Reverse Drop Figures.

The reverse drop figure is set in such a way that corresponding features of each unit are diametrically opposed, therefore each unit figure is both dropped and reversed as illustrated at Fig. 8. When this basis of distribution is adopted, the length and breadth of the rectangle which bounds the unit figure should always be

relatively and respectively of the same dimensions as the subject, otherwise when it is reversed and dropped irregular masses of ground will occur with each repeat of the pattern.

These schemes are not absolutely the only bases used, for frequently the designer devises methods of arrangement entirely his own.

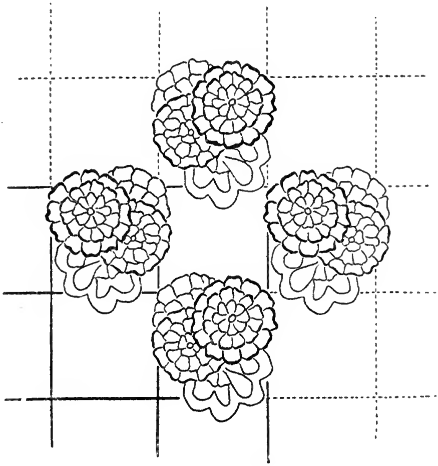


Fig. 8.

Complex Designs.

In designing for all the better class carpets, the safest plan is to make the pattern full size and on specially ruled paper, though not infrequently the design is drawn to $\frac{1}{2}$, $\frac{1}{3}$ or $\frac{1}{4}$ scale. Whichever class of carpet design is used the first essential is to get a pleasing line which repeats and covers well. Curved lines express softness, straight lines and angular forms suggest strength and firmness; the happy combination of these qualities is to be found in all really good designs, and the best of oriental productions. The construction

lines cannot be too well considered before any attempt at growth or decoration is made. These, then require clothing with ornament, which to be interesting must first possess *fitness;* hence, the only rules which can govern designing for woven fabrics are those which naturally assert themselves according to the class of fabric to be produced, and no designing can be good apart from a knowledge of the material in which the design is intended to be displayed. Further, the ornament must not be laboured but appear to be accomplished with ease, its value increasing as the design suggests life, invention and individuality but not excessive mysticism.

Step or Half Drop.

The system known as 'stepping' or 'dropping' is peculiarly adapted to carpet designing, since most carpets are woven in looms, the width of which contains only *one* repeat of pattern.

By using the step or half drop basis, the same figure does not repeat in the same line across until the actual woven design is twice repeated, which imparts a much less confined appearance to the pattern. This device enables the designer to minimise the danger of unforeseen horizontal stripes in his complete design—a danger which is more frequent with side repeating patterns. For this reason the drop repeat is preferable to the straight whenever it is practical. There is also considerable advantage both economically and artistically, since, in the first instance the actual capacity of the jacquard figuring machine for Brussels and Wilton or Jacquard Axminster and the width of the tufting spools for Royal Axminster is virtually doubled, and in the second place, the amount of waste in cutting and planning is reduced to a minimum.

Half Drop Bases.

The half drop pattern can be arranged either on the square, rectangle, diamond, lozenge or ogee basis, since they each provide the fundamental elements for the construction of a typical half drop. These are respectively illustrated at A, B, C, D, E, F, G, H and I, Fig. 9. The diamond or lozenge is perhaps the safest plan to work upon.

The *square* and *rectangle* bases. When either of these plans is adopted the design must be so constructed as to permit the ornament in the left hand in section I of the shaded square, to

correctly fit with that on the right hand side of the shaded section 4, when dropped or lifted as shewn in the sketch plan at A or B. The corresponding numbers in the different sections denote that the ornament is the same.

The *diamond* or *lozenge* bases. If either of these be adopted the unit figure is usually confined within the shape indicated by the

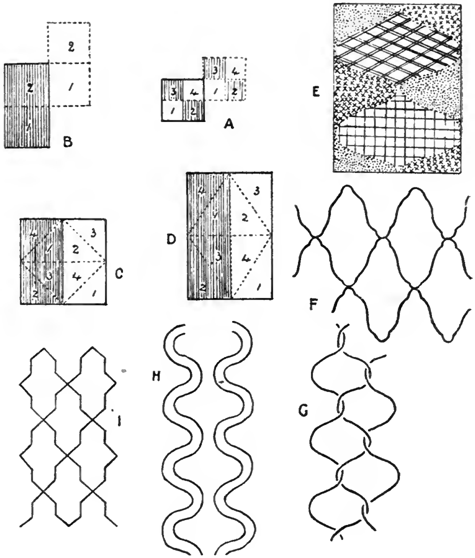


Fig. 9.

dotted lines in the plan at C or D. In the sketch supplied, this plan is divided into four equal triangles, 1, 2, 3, 4. The remaining space in the repeat area contains four triangles—one at each corner which are of corresponding shape and area as the four previously mentioned. These four triangles may be filled with repeat ornament so as to correspond with the two sets of numbers, in which case it is

only necessary to fully work out or 'develop' so much of the pattern as is shaded, since it will be evident from the numbering that the design will 'drop.'

After the centre diamond or lozenge has been filled with ornament, the corners may be and frequently are differently treated; but care must be taken to make the ornament on the lower half of the left hand side coincide with that on the upper half of the right hand side; also, to make the top half of the left hand side, correctly fit with the bottom half of the right hand side in addition to joining well at the top and bottom when the design is dropped and repeated. This is equivalent to the method of first filling the centre of a square, or any repeat area, with the principal mass of ornament, and then filling the remaining space with smaller masses, in proportion to their importance. Fig. 10 is a photograph from an actual carpet designed on this principle.

The *ogee* basis. There are several varieties of this class which may be utilised to produce the half drop, as illustrated at E, F, G, H and I, Fig. 9. The flat ogee at E is a typical example and contains four varieties of pattern in the unit of repeat as indicated by the four different markings. The pattern, it will be observed, is designed to 'step' correctly.

Skeleton Plans, 'Half Drop.'

When the base plan has been decided upon and a new design is to be commenced, a simple method is to begin in the centre of the area of limitation and gradually work towards the circumscribing lines of repeat, taking care to avoid any crowding or gaps in any particular part of the design. It is usual and necessary to extend the complete sketch beyond the bare lines of the repeat on each side so as to ensure correct fitting, perfect covering and even distribution of lines and subsequently of decoration. The skeleton plan should consist of easy and graceful flowing lines, distributed in such a manner as to cover evenly the area of repeat.

The clothing of all lines for *carpet* designs must of necessity be very bold and decided in form and colour. The character of the woven texture restricts any desire the designer may have to secure and display refinement of ornament.

Fig. 10.

PLATE A.

An example of a skeleton plan schemed for a half drop design on the rectangle basis is supplied at Fig. 11. The structure has been devised to satisfy all the requirements for a half drop pattern,

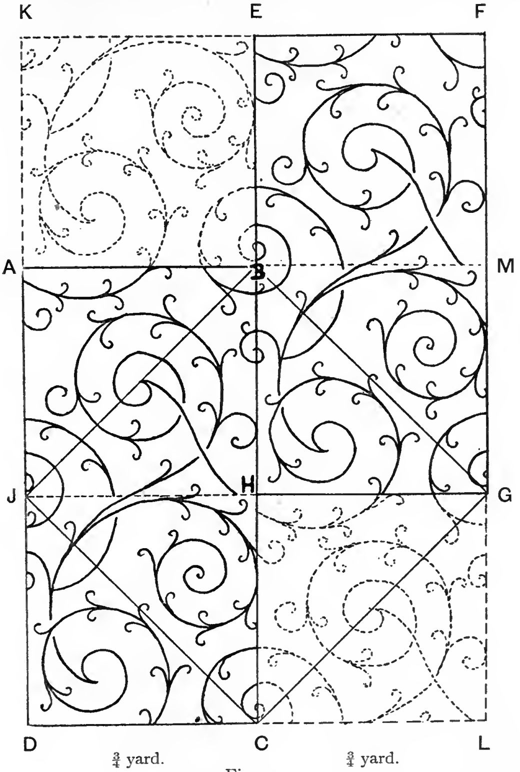


Fig. 11.

on the principle heretofore described. The unit pattern is contained within the rectangle A, B, C, D, and it has been repeated on the right hand side, but one half its length higher up, so that the points

E, F, G, H, exactly coincide with A, B, C, D respectively. It should also be observed that the parts which lie between EB are a fac-simile of those between AJ, and similarly the parts which come between JD respectively join up to those between BH.

After the unit pattern has been dropped as already described, straight lines may be drawn from the point B to J and G, and continued at right angles until they meet in the point C. It will then be found that a diamond shape has been formed within which is enclosed just one repeat of the pattern but involving a different conception and treatment. The second *unit* of pattern in the completed design may be considered to be composed, as it virtually is, within the four triangles JAB, BMG, GLC, CDJ. Note also that these triangles exactly correspond with those marked GHC, CHJ, JHB, BHG. Thus it will be seen that the same design can frequently be made from different bases, though generally speaking the bases and lines of construction influence the character of a design to a very considerable extent.

Ogee Basis Emphasised.

The illustration at Fig. 12 is a photograph from an actual carpet, the pattern of which is designed as a half-drop on the 'flat ogee' basis. In this example, the basis of construction is emphasised. There are two varieties of design in each ogee shape and eight in the repeat, and these when dropped do not repeat until two widths of carpet have been woven. The dimensions of one repeat of the carpet in the loom was 27 in. × 36 in. but when dropped and correctly joined, the area of the repeat of the pattern was 54 in. × 36 in.

The 'All-over' Pattern.

The all-over pattern is usually built upon a square or rectangle. It contains only *one unit* figure in each repeat, and is well suited to give the greatest variety of effect. When judiciously contrived it is difficult to detect the repeat. The area of limitation is first filled in with natural and graceful flowing lines, the possibilities of arrangement of such lines being practically endless. The most important factor to bear in mind is the effect of the pattern when repeated. To avoid any defects the safest plan is to extend some of the lines and ornament into the adjoining repeat and so ensure, on every

Fig. 12.

PLATE B.

side, perfect fitting of the design together with a successful concealment of the repeat (see also testing for repeat on page 24). After the leading lines have been sketched, growth, clothing and detail is attempted but it is essential to avoid overcrowding with detail which cannot be properly expressed. The fabric for which the

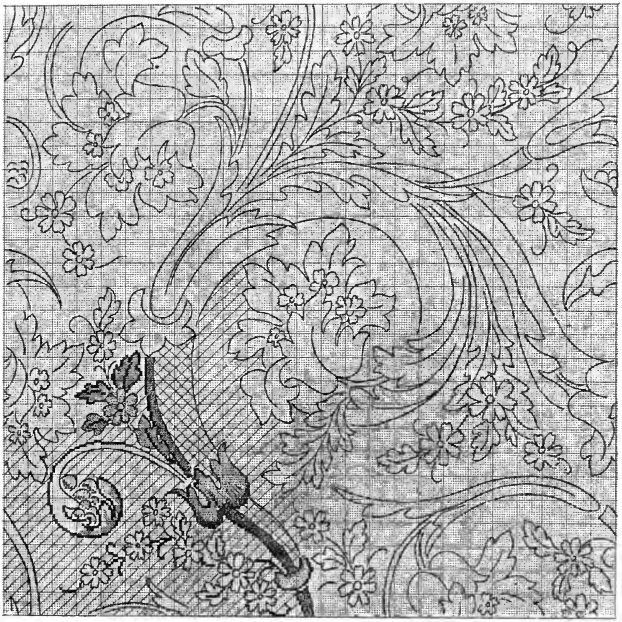


Fig. 13.

design is intended should ever be borne in mind by the designer, and he should always carry out some, at least, of the finest detail to the actual size of the pattern when produced in the carpet. The chief points of the decoration are then blocked out in the order of flowers, leaves and stems, but the effect of each when repeated

must never be lost sight of and care should be taken not to produce the same idea twice, otherwise the repeat will be emphasised instead of disguised. Details or portions of ornament must never be introduced merely for the purpose of filling. A far superior plan is to reconstruct a portion of the ornament which surrounds the awkward space in order to better accommodate it to the whole design. No amount of trouble should be spared to secure variety and evenness of distribution. A good method of testing the distribution and balance of flowers and foliage is to tint them, which enables the

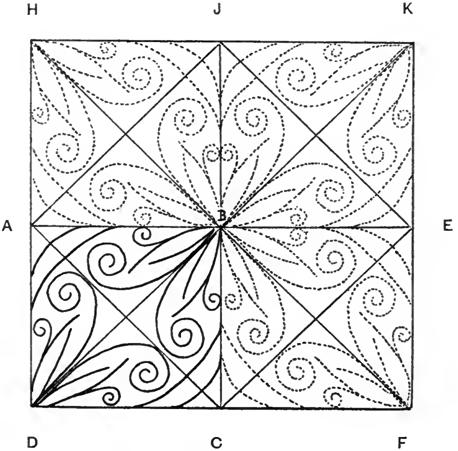


Fig. 14.

designer to perceive at a glance the relative portions of each and their influence upon each other. An illustration of an 'all over' pattern has been designed on point paper, full size and reduced by photography to the dimensions shown at Fig. 13, the bottom left hand corner of which has been developed in the different markings so as to represent the several colours which might be used.

Multi-symmetry. The ideal carpet design is based on multi-symmetry. Though not extensively used at present, a study of past master-pieces reveals the fact

that a very considerable portion of such productions was based on this system of designing.

A multi-symmetrical design overcomes many of the difficulties of 'foreshortening,' in addition to which it possesses the property of being reversed or turned over in each direction so that it appears the same when viewed from any point. This is a distinct advantage, though it does not forbid a carpet design being satisfactory without such a qualification.

The basis of a typical multi-symmetrical pattern is on radiating lines evolved within the diamond or triangle of which the illustration submitted at Fig. 14 is an example. The whole scheme is ambitious since if utilised to its utmost limit a quarter of the whole design need only be prepared on point paper *e.g.* If the portion of pattern enclosed within the rectangle A B C D be reproduced on the jacquard cards and these in turn be worked from D C to A B, the ornament enclosed in the rectangle will be produced. Then, if the card cylinder together with the jacquard cards is made to revolve in the contrary direction *i.e.* from A B to D C, the same pattern will be the result, but in the reverse order as shown within the rectangle H J B A. This two-fold operation is repeated until the required length of carpet has been woven. On referring to the design it will be found that the section of pattern in the rectangle A B C D exactly corresponds with that bounded by J K C B, and similarly the ornament within the rectangles H J B A and B E F C perfectly agree with each other. Consequently a second length of carpet can be made and joined to that of the first in such a way that the points A D shall exactly fit with the respective points J B. The complete repeat of the pattern will then be twice as large as the figuring capacity of the jacquard machine, four times the size of the pattern contained on the cards enclosed within the rectangle A B C D and eight times the semi-figure enclosed within the triangle A D C, and sixteen times the unit figure shown separately at Fig. 15. A pattern which satisfies all the conditions of a multi-symmetrical design may have its basis of conception and lines of construction

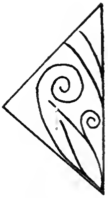


Fig. 15.

confined within the square or rectangle. Fig. 16 is an example of such a pattern. This design will not admit of lifting or dropping but it can be turned over or wielded so that the same parts on the left hand side shall correctly join with those on the right hand except in the reverse order. If the sections are wielded, alternate widths might be brushed conversely in the finishing and so obviate a tendency to a difference in shade or tone in the alternate sections. When very considerable lengths of carpet are required it is usual to cut the cards for one complete repeat of the pattern and so avoid the inconvenience of reversing the motion of the card cylinder. But for patterns and short lengths the advantage of the method described previously is obvious.

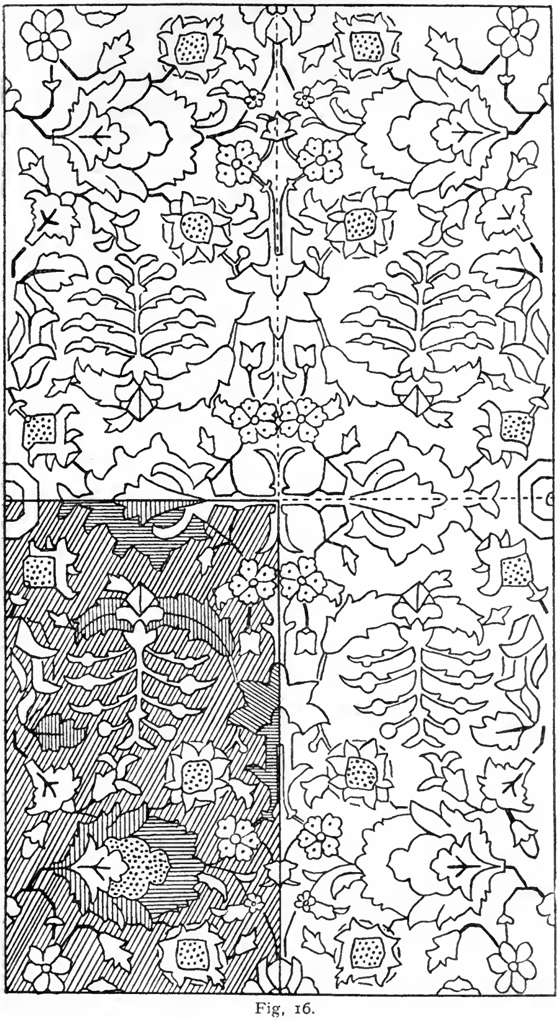
Border Patterns.

Borders are used in carpets for stairs, rooms, corridors, mats and rugs. For mats and rugs the design, idea or pattern should be a complete unit, the chief masses being in the centre and arranged symmetrically or rather multi-symmetrically. A repeating pattern is required for stairs, rooms and corridors, and the sides and ends must be duplicates of each other respectively. The corners being structurally the weakest should be heavier in ornament to secure weight and balance. The border should add value to the filling by contrast—when the filling is elaborate the border may be simple, whereas when the centre is severe the importance of the border is increased and should be full and interesting. Where there is similarity of design in border and filling a contrast is usually acquired by colour.

Sometimes with the object of keeping the main border distinct from the filling one or more supplementary borders are introduced.

On the contrary in rugs, corridor and stair carpets, and some *seamless* squares, the structural lines and ornament for both filling and borders may and often do *overlap* each other. In such cases the design in the border permits of greater contrast with the filling than is necessarily the case with those carpets in which divisional *straight lines* are run between the border and the filling.

In rug designs for modern use the interchanging type of filling treatment is appropriate, but fashion and mechanical limitations will always be the governing factors on these points irrespective of taste.



Fig, 16.

Two examples of rug designs are supplied at Fig. 17 and 18. The former is a photograph from an actual rug design and woven as a turnover *i.e.* the first half of the pattern was prepared on point paper from which the cards were cut; these were alternately worked backwards and forwards until the desired quantity of rugs had been produced. It will be observed that the design has been built on the multi-symmetrical principle, and that the corners have been strengthened with ornament. Only so much of the carpet has been shown as is necessary to illustrate that the design turns over.

The latter figure is from a point paper design fully prepared, coloured and ready to be reproduced in the carpet. This design has been schemed on the principle technically known as the 'wield' *i.e.* the ornament instead of being turned over wields from right to left and the figures in the border are made to run round the rug in the same direction throughout. In the figure supplied, the pattern has been wielded round for the purpose of illustration.

Width of Borders.

For a 27 inch stair, corridor or rug design, the width of border is usually $4\frac{1}{2}$, 5 or $5\frac{1}{2}$ inches. There is really nothing in the mechanism to limit the width to any of these or other dimensions. It is purely a question of balance of border, filling, and taste.

The width of borders for room carpets is usually $13\frac{1}{2}$, 18 or $22\frac{1}{2}$ inches, generally expressed as $\frac{3}{8}$, $\frac{1}{2}$ or $\frac{5}{8}$ yard border.

Looms have been made of such a width that *seamless* carpet squares with borders could be woven to cover any ordinary sized room. All such carpets were of necessity limited to a few standard sizes. The restrictions are, however, so numerous that they appear to outweigh the advantages and consequently they have not met with general acceptance.

Usually the carpet is woven in separate widths and afterwards stitched together. The full width of the carpet is generally some multiple of 27 inches except in rare instances. The length may be any convenient number of repeats of pattern plus the border. When the border is $13\frac{1}{2}$ inches wide, two borders may be woven side by side in the same loom and afterwards cut up the centre. In order to facilitate cutting and prevent fraying, 5 splits in the centre

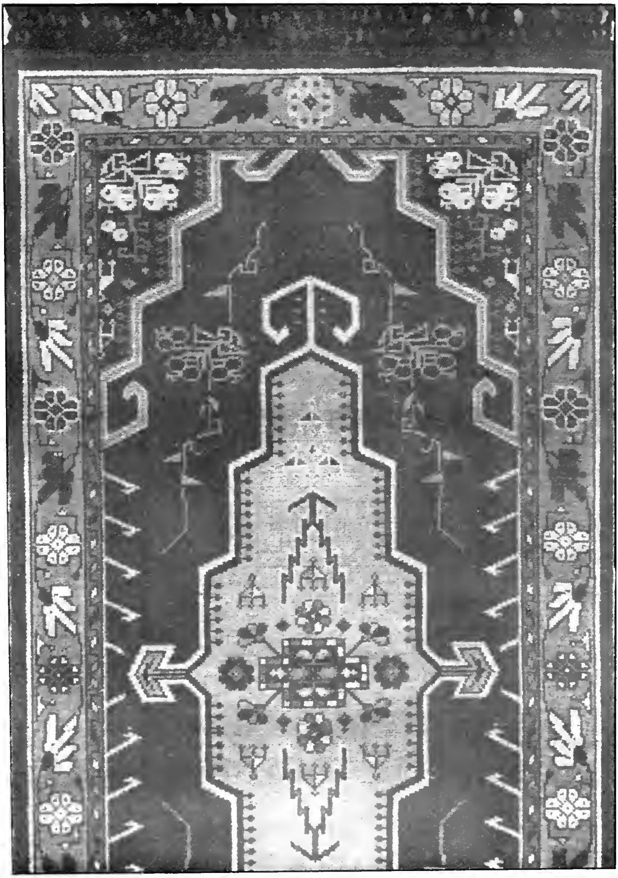


Fig. 17.

PLATE C.

of the reed are left without worsted, the centre split being absolutely free. After the cutting operation these pileless edges are turned to the underside of the carpet and stitched. When $\frac{1}{2}$ or $\frac{5}{8}$ yard borders are required the harness must be cast down to suit the width, unless as is now more frequently the case, a portion of the centre pattern or filling is woven simultaneously with the border; under such circumstances care must be exercised to make the section thus woven not only join well up to the sides and corners, but correctly repeat with the centre.

The borders and filling although distinct must nevertheless appear to belong to the same scheme of decoration. In order to obtain this effect of unity, the border should be composed of the same or corresponding forms as the filling but differently treated.

Chlidema Squares.

Prior to the introduction of the Chlidema square in the year 1882, the border pattern was either designed to turn or run round the corner or some simple repeating pattern was made. In either case the border was separately woven in continuous lengths and afterwards cut, stitched to the filling and mitred at the corners to suit the dimensions of the square of carpet required. There were three objections to this system, viz.:—

1. The mitring made the corners clumsy.
2. It involved the waste in cutting, of a triangular piece of carpet at each corner.
3. It resulted in an apparent difference in tone or shade of the four borders, three of which were different from the centre filling. This defect was due to the border being woven all one way, then cut and placed at right angles for mitring; the difference in shade was greatest in Wilton and Velvet pile structures.

In order to overcome these objections, the 'Chlidema' principle of designing, cutting, and weaving was invented and patented in this country and U.S.A. The word 'Chlidema' is an arbitrary term being invented and registered under that title, chiefly for the purpose of distinction. The necessity for this invention is a forcible example of the restrictions and limitations which *manufacture* exercises upon art when commercially applied. Though there is an

increase in cost of designing, cards and card cutting, by this method, it is relatively cheaper, when account is taken of the saving of waste of carpet effected in cutting, in addition to its uniform tone of colouring and general neatness in appearance.

The patent right having expired several years ago it is now common property.

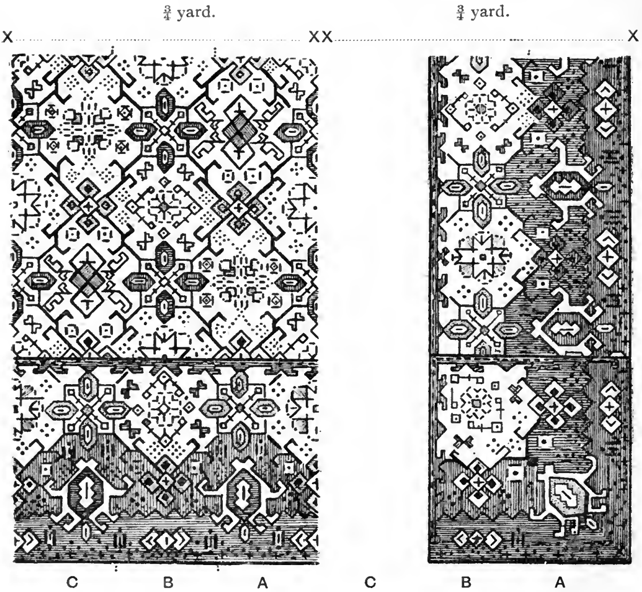


Fig. 19.

Strictly speaking there are six separate designs :—

1. One for the right hand corners } Turnover.
2. ,, ,, left ,, ,, }
3. ,, ,, right ,, border. } Turnover.
4. ,, ,, left ,, ,, }
5. ,, ,, top and bottom borders.
6. ,, ,, filling, which repeats.

But the working designs only involve the making of one repeat of the right hand border and corner, and one repeat of the bottom border and filling.

This is fully illustrated at Fig. 19, from which sections the whole of the jacquard cards can be cut, and the complete carpet designs woven.

The carpet is woven in sections $\frac{3}{4}$ yard wide, in a $\frac{3}{4}$ Brussels or Wilton loom.

The jacquard card cylinder is in three divisions; a separate card is used for each division, so that three cards are required to be

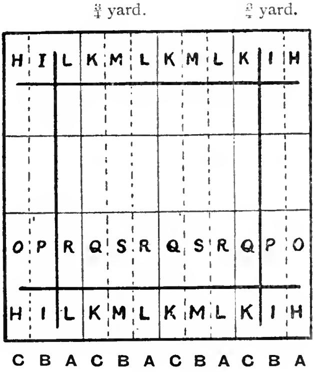


Fig. 20.

placed end to end, for the full width of the card cylinder, row of pile and wire inserted.

For the purpose of convenience and future reference, each division of cards on the cylinder may be suitably numbered or lettered, beginning (in this treatise) from the right hand side, using the letters A, B, C, and with the cards above the weaver in front of the loom.

Plan of a Chlidema.

A plan of a Chlidema Square is fully illustrated at Fig. 20. The ornament for the corners is represented at HI, that for the side borders at OP, for the cross borders at LMK, and for the filling by the letters RSQ.

The repetition of any of these groups of letters in any part of the plan, indicates that the same ornament is to be repeated, except that the opposing borders and corners are respectively reversed.

The letters ABC at the base of the plan indicate the particular card on which the represented portion of ornament must be cut.

Each border is ½ yard wide, and a ¼ yard of filling is always woven along with it. Two cards wide are used to control the threads belonging to the side borders and corners on each respective side, the remaining card being used to control the portion of filling which joins up to the border and top and bottom portion of borders which fit up to the respective corners.

Three separate weavings are required:—

I. One for the right hand border and corners, including the portion of filling and cross borders which go with them.

II. One for the left hand border and corners, including the portion of filling and cross borders which respectively go with them.

III. One for the cross border and filling.

These separate weavings require two sets of cards each, *i.e.*, six sets in all.

I.
1. One set is used for the right hand corner HI, and portion of cross border K.
2. One set is used for right side border OP, and the part of filling Q.

II.
3. One set is used for the top and bottom border LMK.
4. One set is used for the filling RSQ.

III.
5. One set is used for part of the cross border L, together with the left hand corner IH.
6. One set is used for the portion of filling R, together with the left hand side border PO.

The loom is fitted up with a cross border jacquard which contains two card cylinders, a set of cards being used with each cylinder respectively. Either cylinder, together with its respective set of cards, can be brought into action at will—automatically or by hand.

Consequently, during the period that the cards and cylinder which specifically produce the corner pattern H I and section K are in

action, the card cylinder and cards belonging to the border O P and filling section Q are stationary and vice-versa. Similarly with each of the other weavings and their corresponding sets of cards.

The width of the repeat of the top and bottom border is always the same as that of the filling which invariably corresponds with the $\frac{3}{4}$ width of loom and capacity of figuring machine. The length of the side borders must always coincide with that of the filling. The top border may be joined to the carpet at the end of any repeat or part of a repeat of centre and border. If new patterns are being prepared, it is usual for the designer to make his filling repeat in a perfect square, so that the top and side borders will be of corresponding dimensions. It frequently happens, however, that the customer submits a sample of carpet where the pattern is longer than its width, and asks for a carpet square with the filling the same as pattern on sample, and a border to match.

Though these suggestions involve limitations and crampings, a designer for the trade must ever be prepared to receive hints of what is wanted without protestation and reproach. The difficulties thus presented must be resolutely faced and overcome if he is anxious to secure trade, and have his work recognised.

CHAPTER II.

Colour.

Taste—An Important Factor.

As an introduction to the subject of colour something may with advantage be said on *Taste*.

The sense by which we receive and distinguish the pleasure of food has, in all probability, given rise to the use of this word in the metaphorical sense in which it is now used.

When considered in its relation to colour and colour combinations, it represents the power to distinguish the fine gradations of excellence or otherwise, together with the faculty of appreciation which an individual is capable of exercising, in respect to that which is good, bad or indifferent, and in addition the ability to produce pleasing combinations.

Faculty of Taste.

The faculty of taste is common to all people more or less. All, in a general sense can appreciate beauty of colour and design in one form or another and appropriate what is orderly, proportionate, harmonious, grand or novel. If then most persons experience much pleasure from the actual impressions of colour, it naturally follows that those fabrics woven with the best chromatic assortment will command a first consideration from customers. Further, the keen competition experienced by manufacturers in their endeavours to secure a market for their goods, involves their engaging men who are not only artists in respect of design, but primarily colourists with cultivated tastes and natural capabilities. This latter qualification is very essential, since without it, the retention of what has been taught is almost impossible.

Though none are absolutely devoid of taste, the degree in which it is possessed is widely different. In some it is so small,

that the faculty may be said to be virtually a negative quantity; their power of appreciation is so meagre that even a cloudless sky studded with stars will prove to them an insipid object. They will turn with indifference from the green mantle of spring, from the foliage, blossoms, buds and flowers which adorn the countryside, to contemplate the gaudy coloured materials with unfriendly tints. Their ears which cannot rightly estimate the notes of the thrush, the linnet or the lark will be regaled and ravished by the strumming of a fiddle, touched by a musician whose chief ability lies in his fingers or loud noises which are devoid of bcth order and time.

Natural Endowment Rare.

The powers of acute discernment and lively enjoyment of most of the refined beauties of nature and art, are seeds sown sparingly among the human race, a fact which renders a higher culture necessary in order to approach nearer the goal of perfection.

These facts have probably induced many to assert, that taste is a natural quality independent of art or training, in the same sense as smell, sight or hearing.

An Improvable Faculty.

Undoubtedly the principal factor in the composition of *taste* is natural endowment; it nevertheless differs from the senses in this respect, that whereas they are more completely *finished* by nature, *taste* can only be brought to perfection by proper cultivation, for taste pretends to judge not only of nature but also of art, which judgment is founded upon observation and comparison.

Genius may shine without the help of art, but taste must be cultivated by art before it will produce agreeable fruitage; yet on the contrary study and precept will avail little without the aid of nature. There are many evidences which support the necessity of culture; of these, two only need be cited. First, the refined taste of civilised as compared with uncivilised nations and second, the evident difference between the learned and the illiterate, which difference is so great that no other reason can be assigned but training and education. This fact when once clearly realised should give encouragement to all who desire to improve their natural gifts.

Methods of Improvement.

Taste may be improved by exercise and also by the application of good sense and reason. In its most perfect state it is undoubtedly the result both of natural aptitude and application.

The chief of these factors—*exercise*, may be demonstrated by the following examples:—'Touch' is so finely developed in many woolstaplers, spinners and manufacturers, through continual practice, that they can distinguish the several qualities and properties of wool by simply handling it.

The 'ear for music' is gradually improved by constant exercise. At first only the simplest compositions are relished, but by degrees this pleasure is extended, for the ear appreciates finer melodies until eventually it can thoroughly enjoy the intricate and compounded pleasures of harmony. Likewise an 'eye for beauty' of colour and colour combinations is only acquired by gradually becoming conversant with the works of best masters and the assistance of good teachers. Attention to the best and most approved harmonies, a study of the best productions, and a comparison of lower and higher degrees of the same beauties all operate towards the refinement of taste. When one is beginning his acquaintance with the works of past masters in design or colour, he is at a loss to understand and point out the several excellencies or blemishes, he knows not on what to rest his judgment, his remarks must be general, he can only say that he is pleased or otherwise; but continue to exercise in this direction and by degrees his taste becomes more enlightened and exact, he begins to perceive not only the character of the whole but the beauties and defects of each part.

Next to exercise, *reason* and *good sense* have an extensive influence on all that contributes to good taste *e.g.* when a beautifully coloured woven design is examined, much of the pleasure ordinarily derived, will be increased if the plan or scheme suggests forethought by having all the parts arranged with due propriety. In all combinations where there is any reference of parts to a whole or means to an end, the understanding will always have a great part to play.

Spurious beauties and unnatural characters may temporarily

please, but only because their opposition to nature and good sense has not been examined or perceived. If it be shown how nature might have been more justly imitated or represented, the illusion will be dissipated and these false beauties will no longer please.

Capriciousness and Diversity.

Taste is sometimes said to be capricious; its variations have been so great and frequent as to create a suspicion that it is arbitrary, being wholly dependent on changing fashion. If this were true then all studies or regular enquiries concerning taste are vain as a consequence.

Some of the experiences of the past, when considered only on the surface would appear to countenance this theory. For a long period the *Grecian Models* of architecture were esteemed the most perfect. In succeeding ages the *Gothic* superseded. Afterwards the Grecian tastes again revived in all their vigour and engrossed the public admiration. In a similar sense, the same is true in every other walk of life into which taste may be said to enter.

Diversity of taste prevails among mankind, but this does not necessarily infer corruption or oblige us to seek for some standard in order to determine the right. The tastes of persons may differ very considerably in respect to the object and yet none of them be wrong—one admires the simple, the other ornamental style, or to borrow a foreign illustration, one prefers poetry another history etc. There is but *one* standard of *truth* and *one* only, but *beauty*, the object of taste, is *manifold*. Thus taste admits of latitude and diversity, but this admissible diversity can only have place where the *objects* of taste are *different*.

Where there is marked difference of opinion with respect to the same object—one declares it to be ugly whilst another admires it as beautiful—it is no longer diversity but direct opposition of taste; one must be right and the other wrong, and in such a case, appeal must be made to some *standard* to determine which is right.

Standard.

These questions then naturally arise. Is colour and the taste for colour reducible to a science? Are there laws and principles which govern all harmonious and agreeable combinations of colour, or, are such combinations merely

the result of caprice? Is there any standard for taste to which we can appeal and so distinguish between good and bad? or, are we to hold by the proverb, "There is no disputing of tastes"? If there be no standard of taste, then it follows as a natural consequence that all tastes are equally good—a position which no one will seriously maintain.

A *standard* properly signifies that which is of *undoubted authority* and is used to test other things of the same kind. A standard weight is that appointed by law to regulate all other measures and weights; this standard is arbitrary but of indisputable authority. The standard of appeal for design and colour may frequently be nature; in all such cases of comparison, *reason* has full scope for asserting its influence—for approving or condemning. Conformity to nature is an expression frequently used without any distinct or limited meaning.

Taste, then is founded on an internal sense of beauty natural to humanity and which in its application to particular objects, is capable of being guided and enlightened by *reason;* but since no single individual, possesses or has ever possessed, *all* the human faculties bestowed by nature, *i.e.* an internal sense of the exquisite and a just and unerring reason, there is no human perfect standard. Then it follows, that that which concurs most with the general sentiment is the *standard* to which all must conform; all will agree that sugar is sweet and herbs bitter, and to dissent would be folly. Is it therefore necessary to collect the voices of others before forming any judgment? Certainly not! There are principles of reason and sound judgment equally as applicable to matters of taste as to science and philosophy, and those possessing good taste whether natural or acquired will always endeavour to assign some reason for their decisions.

Perfect Taste, Delicacy and Correctness.

Taste when brought to its most refined state is reducible to two qualities—delicacy and correctness. Delicacy of taste is the organ or power to perceive beauties which lie hidden from the ordinary eye. A person endowed with this quality feels strongly, he sees distinctions and differences where others see none—the most latent

beauty does not escape his notice, he is sensible of the smallest blemish. *Correctness* of taste respects chiefly the improvement which that faculty receives through its conforming with the understanding. It is never imposed upon with counterfeit beauties, but estimates with propriety the comparative beauties which are brought under its observation and can assign the principles from whence their power of pleasing flows. These two factors mutually imply each other since no taste can be exquisitely delicate without being correct and vice versa.

Delicacy is chiefly seen in discerning the true merit of a work, correctness in the power of rejecting false pretensions to merit. Delicacy leans more to feeling; correctness to reason. The former is the gift of nature; the latter the product of culture and art.

Colour Theories.

Successful Colourists.

From the foregoing pages it will be gathered that the pedestal of all colourists' successes, rests not exclusively on natural endowment of taste, but equally upon personal application, a systematic study of the science of colour, a determination of colour harmonies and their opposites and the observation of pitch or key in the same combination of colour.

The laws and rules of colour will guide the workman who does not disdain them and direct the customer or critic in exercising his judgment but the theory of colour like most other theories must be thoroughly understood before agreeable harmonies and contrasts can be satisfactorily and readily applied.

Preparatory to any definition of colour theories, it can without hesitation be asserted that a systematic study of the natural phenomena of colour, either by *interference*, *absorption*, *reflection*, *transmission* or any other scientific method together with a careful observation of nature's colour combinations and practice will heighten the ability to appreciate and combine colours which in their total arrangement are harmonious.

Colour Defined.

There are two chief theories of colour, viz:—The 'Light' theory and the 'Pigment.' The former is the more useful for purpose, study and training, but the latter, being allied with material substances, is of the greatest practical advantage.

It will however assist to a more correct understanding of colour if the composition and analysis of white light be first briefly considered.

Light is something which comes from a luminous body to us; this something was considered by Sir Isaac Newton to consist of very fine atoms, too fine almost to think of, but moving at the rate of 186,000 miles per second. It does not however consist of matter shot towards us but of undulations caused by the rapid movement

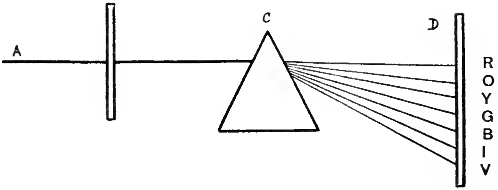


Fig. 21.

of the atoms composing the light. This vibratory movement generates waves in other particles with which they are in contact and as a consequence is sometimes spoken of as the 'Undulatory theory.' These waves travel out in all directions and finally break upon the retina of the eye, (the seat of vision) and thereby produce, in some inexplainable way, the sense of light. They vary in length—when about $\frac{1}{39000}$ part of an inch, they produce the sensation known as 'red,' when only $\frac{1}{41000}$ the sensation produced is called 'orange,' at $\frac{1}{48000}$ it is 'yellow' and as the wave lengths are continually reduced the sensations pass into green, blue, indigo and violet respectively.

These several wave lengths may be arrested in whole or part by a simple process; thus in a darkened room if a small beam of

white light, Fig. 21, A, be made to pass through a glass prism C or a triangular bottle containing a quantity of carbon-bisulphide, or other suitable medium, it becomes refracted or bent out of its straight course, but all its parts are not refracted alike, *i.e.* through the same angle which increases from red to violet. The denser the medium the greater the refraction, but the angle of refraction is always the same for the same medium. If these several refractions be allowed to fall on a clean white sheet D, instead of a simple streak of white light a band of very bright colours will be seen, according to the respective wave lengths, whose number is indefinite but for the sake of distinction they have been grouped and named violet, indigo, blue, green, yellow, orange and red. As

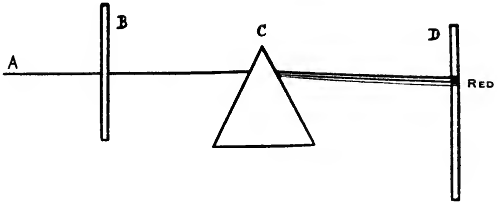


Fig. 22.

an aid to memory the first letter of each of these words placed in order form the empirical word 'vibgyor.'

Absorption and Reflection.

The phenomena of colour will be further simplified by an explanation of the theory of absorption and reflection which theory can be best demonstrated by the analysis of 'coloured' lights; *e.g.* If a streak of white light A as indicated at Fig. 22, be made to pass through a coloured glass (say red), represented at B, before it is allowed to pass through the prism C to the screen D, the visible effect on the screen will be *red*—the same colour as that of the glass B through which the ray of light was first transmitted. This experiment shows that the coloured glass B has absorbed all the rays which go to make up white light, except red and these it reflects—in this instance, transmits.

A similar result can be obtained by substituting either a blue or a yellow glass for the red, when the colour effect on the screen would be blue or yellow according to the glass used.

If the colour of the glass is a *compound* and not a primary or fundamental one, several colours would be visible, which if compounded in corresponding proportions and hues should produce a colour which agrees in hue with that reflected by the tinted glass through which the light was transmitted.

Complementary Colours.

Since these respective portions are the constituents of white light the reflected portions are the *complete— ment* of those which are absorbed and as a consequence they are named 'Complementary'; thus, red substance is considered to absorb blue and yellow and reflect red and since a compound of blue and yellow produces 'green'—green is known as the complementary of red. A blue coloured substance absorbs red and yellow and as a compound of these two produces 'orange'—orange is called the complementary to blue. A white substance reflects approximately all the rays that constitute white light, while black absorbs them.

The following arrangement of colours will be found helpful and useful for reference:—

PRIMARY.	ABSORBED COLOURS.	COMPLEMENTARY.
Red.	Blue and Yellow.	Green.
Blue.	Red and Yellow.	Orange.
Yellow.	Blue and Red.	Purple.
White.	None.	Black.
Black.	All.	White.

The complementary theory receives forceful emphasis by practising the following simple experiment. First, intently fix the eye for about a minute upon a small coloured spot, say red upon a dark or neutral ground, then immediately afterwards direct the eye to another dark ground when a spot of a different colour will appear equal in area to the red but directly opposite in colour, viz: green; this is called the 'accidental' colour which is also the complementary. A corresponding result would be experienced if the eye were fixed on a yellow spot in a similar manner and later directed to

neutral ground as in the first instance—a purple spot the complement of yellow would take its place. The explanation of such a phenomena would appear to be that the eye, having become fatigued by too long an observation of one colour, seeks rest in another which it can only find in its opposite or complement.

In every such test the accidental colour will be found to be the complementary of the coloured spot examined.

In a theoretical sense and in accordance with the light theory, complementary colours are those which, when united, produce white light. In practice they are those which are most distant from each other and produce the greatest possible contrast. When in juxtaposition they mutually improve, strengthen, purify, intensify and make each other more brilliant by their contrast.

Pigment Colouring Materials.

Pigments, or as they are sometimes called artificial colouring materials are derived from natural sources. The following are a few of the chief of these colours and their sources:—

1. Bister (hue brown) is the soot from wood ashes.
2. Black (blue) comes from charcoal of the vine stock.
3. Black (ivory and bone) is obtained from ivory chips.
4. Blue (Prussian) is produced by fusing horses' hoofs and other refuse of animal matter with impure Potassium Carbonate.
5. Carmine, Crimson, aud Scarlet Crimson are all furnished by the cochineal insect.
6. Chinese White is made from zinc.
7. Gamboge (hue yellow) is the product of the yellow sap of a Siam tree.
8. Indian Ink is made from burnt camphor.
9. Lake Colours (various) are derived from roots, barks and gums and the purple lake from the cochineal insect.
10. Red (Turkey) is obtained from the madder plant which grows in Hindostan.
11. Raw Sienna is natural earth from the neighbourhood of Sienna (Italy).

12. Raw Umber (hue brown) is an earth found near Umbria, Italy, which is burnt.
13. Scarlet is Iodide of Mercury.
14. Sepia (tone black) is obtained from the cuttle fish and is the inky liquid which the fish discharges in order to render the water opaque when it is being attacked.
15. Ultramarine (real) which is very scarce, is obtained from the lapis lazula—a precious stone.
16. Vermillion is got from quicksilver ore.
17. Yellow (India) is obtained from the camel.

Simple and Compound Colourings.

All colouring materials are divisible into two classes simple and compound.

Simple colours are those which cannot be produced by the mixture of other colours; these are the fundamental or *primary* colours.

Compound colours are those which are produced by the mixture of other colours.

The three colours Red, Blue and Yellow, are generally considered to be the fundamental basis of all colour and in the preparation of all artificial colours, any hue may be produced and with suitable admixture of black and white any tone or tint can be obtained. It should be noted that only the prismatic colours are pure, consequently all pigment colours are impure. The following typical representatives are supplied of the three primaries:—

Prussian Blue as representative of Blue.
Gamboge ,, ,, Yellow.
Carmine ,, ,, Red.

Mixture of Simple and Compound Colours.

When the primaries are mixed in pairs, three additional colours of separate and distinctive hues are produced called 'secondaries' and if these are mixed in pairs three more colours of different shade are made and are called 'tertiaries.' The table below shows the three sets of colours in their respective relations to each other.

Primaries	Red Yellow Blue.

Secondaries	Orange	Red, Yellow
	Purple	Red, Blue
	Green	Yellow, Blue
Tertiaries	Russet or Brown	Orange, Purple
	Citron	Orange, Green
	Olive	Purple, Green

The proportions of each primary required to produce a typical secondary varies largely according to its relative luminosity; thus, red, being less luminous than yellow, requires a greater mass of colour to neutralise or balance the more luminous shade when contiguous, and a relatively greater proportion of colouring material when mixed.

These proportions are as 3, 5, and 8 for yellow, red and blue respectively, which is in the inverse ratio of Field's estimated luminosities, but individual judgment and feeling is essential with every combination.

Note :—A mixture of two or more pigment colours is frequently improved by a slight addition of white.

Colour Scales, Simple and Compound.

When colours are mixed as described above the compound is called a *Hue* of that colour of which it contains the most. When they are modified by the addition of black, they are known as 'tones' and broken colours; when they are mixed with white they are frequently termed 'tints.' Note the term *tone* is frequently applied to all and any colours to indicate their luminosity and shade. The series of hues, tones or tints of any given colour is defined as *scale*. The knowledge of these simple definitions should greatly assist in accounting for the effects of colours and in communicating to others the results of the impressions received from them and which in the absence of precise language cannot be clearly expressed. An

illustration of a scale of greys is given at Fig. 23. In the production of any scale of colours, it is advisable to arrange that the distance between any two contiguous shades should be relatively the same and the colours in each successive shade should be in such proportions as will make each succeeding tone thus appear relatively equidistant.

This may be difficult to the beginner but the following practical test, based on an optical illusion, the theory of which is subsequently proved, will be found useful. First, number consecutively each shade in the scale, then place shade 2 between shades 3 and 4 and if equidistant it will appear similar to shade 1. Again, try shade 3 by placing it between shades 4 and 5. It should appear equal in depth of tone, hue or tint as number 2 in order to satisfy the conditions of equilibrium.

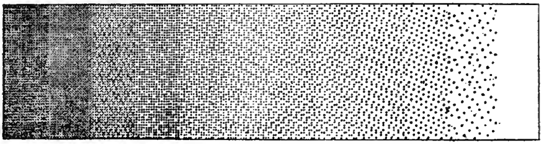


Fig. 23.

The student will experience much improvement in his ability to match and determine the quality and properties of any colour, if he will but exercise the trouble to produce a series of scales of hues, tints and tones, after which he should produce a compound series of scales of colour in circular form, which method is defined by Chevreul as the 'Chromatic Circle;' such a diagram is useful for representing all the modifications of tones, tints and hues of colour, as well as the relations which exist between those that are complementary to each other, since the two extremities of any one diameter indicate the complementary and contrasting colours. This is too, a convenient method of determining the relative 'height' in tone, of any colour and its opposite, together with a ready means of expressing ideas about colour in a geometrical

form and with a certain degree of exactness which would otherwise be very difficult. Such a chromatic diagram is furnished at Fig. 24. The method of constructing it is explained as follows :—

1. Describe a circle of any suitable diameter, divide it into three equal parts R Y B representing the three primary colours red, yellow and blue respectively.

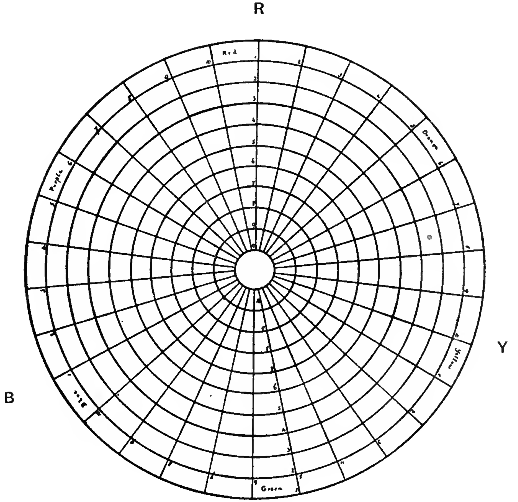


Fig. 24.

2. Divide each arc into ten or any suitable number of equal parts and number them in rotation. From each point draw radial lines to the centre of the circle.
3. Divide the radius into ten or more equal parts. Through each point on the radial line draw concentric circles with R Y B, but leave a convenient portion in the centre neutral.
4. At the extremity of each arc of circles R, Y and B, and in each centre affix the colours red, yellow and blue respectively.

5. From R to Y produce a scale of hues by mixing increasing quantities of yellow with decreasing quantities of red.
6. From Y to B similarly produce a scale of hues by mixing yellow and blue, and also from B to R produce a scale by similarly mixing blue and red, taking care to keep each colour as distinct as possible from its contiguous hue.
7. Beginning with each colour at the extreme diameter of the colour circle, add increasing quantities of black or white or both to each respective colour so as to fill every division towards the centre. The addition of black will produce a series of scales of tones, and white, a series of scales of tints.

A compound series of scales drawn and coloured after the foregoing description have been reproduced in colours at Fig. 25, Plate I., a small portion of which has been left blank for the purpose of illustration and construction.

In this chromatic circle, the colours which are diametrically opposite, in the series of scales of hues forming the outermost circle are complementary. Thus it will be perceived that red and green are so opposed, as are also blue and orange and yellow and purple, and these are each respectively complementary.

The compounds of these colours in their respective scale have their complementaries and contrasting tones, thus :—purple inclining to red has its complement in yellow inclining to green, and red inclining to blue finds its complement in green inclining to orange and similarly with other compounds.

In each concentric series of scales within the outer circle of hues, those colours which are diametrically opposite may be described as *contrasting* which explains the fact that though complementary colours are contrasting, contrasting colours are not necessarily complementary.

The addition of white or black to each radial scale of opposite colours just balances each other while the remaining amount of the 'hue' colour approximately neutralises its opposite. These respective compounds are therefore appropriately named contrasting colours.

The production of colour schemes on this principle is very

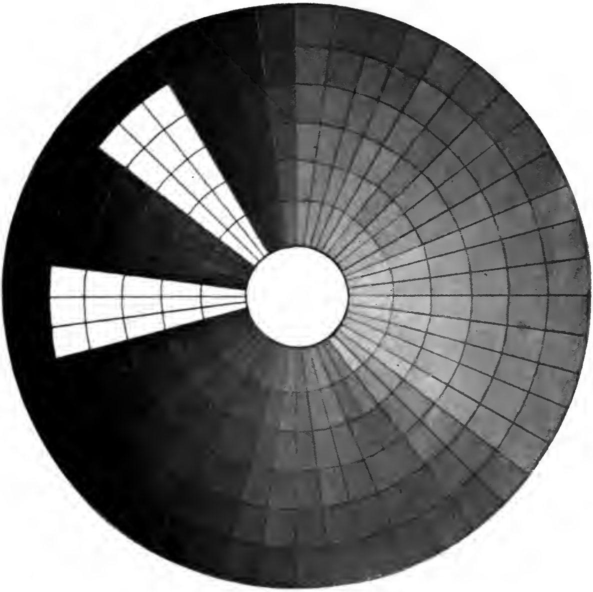


Fig 25.

Fig 26.

PLATE I.

helpful as an exercise in imparting instruction and assisting to a more correct appreciation of colour laws and their combinations. In several instances it has been found to be of some advantage in practice.

Classification. Colours are classed as luminous, warm and cold. The luminous in their relative order are:—yellow, orange, red and light green.

The warm in order are:—Red, orange, yellow and light green.

The cold are:—black, blue, violet and deep green.

White, yellow and red catch the eye before other colours, hence they are sometimes spoken of as advancing colours.

Visual Modifications of Colour.

There are four chief conditions under which colour may be visually modified.

1. By illumination.
2. By materials and surface.
3. By relative proportions and intensities.
4. By juxtaposition.

The explanation of the science of this phenomena, though otherwise a welcome and inspiring task, cannot be fully dealt with in this treatise for lack of space. The subject is nevertheless of such importance as to demand some passing note.

Illumination. It is well known that when coloured bodies are seen under different degrees of illumination a change of effect takes place, which in some instances is so considerable as to defeat any attempts to satisfactorily examine coloured woven fabrics or to mix coloured pigments or match shades in gas or any other artificial light. It will be interesting to the student and the practical colourist, to enumerate here a few of the chief modifications which occur and the law which governs all such changes.

Generally a bright illumination makes all colours tend somewhat toward yellow; thus *e.g.* violet in slight illumination inclines to purple but when in a more intense light it tends more towards

blue. Purple also inclines to blue under similar conditions while green appears yellowish green. Red, the most stubborn of all colours resists these changes most, but if the light be very strong, it then inclines somewhat towards orange.

Speaking generally, colours when seen in a diffused light appear weaker and manifest a uniform tendency towards dark blue and purple. It might also with advantage be noted that since gas light is *deficient* in violet, blue and bluish green rays, its resultant shade inclines to *yellow* and not white, hence colours examined in gas light are equivalent to those seen in a *yellow light.*

With moderate illumination darker objects become more like the darkest, while with the greater illumination bright objects appear more like the brightest.

Surface Modification.

The visible effect of colour is always slightly modified in its application to different substances and according to the condition of the surfaces of the materials. Coloured bodies reflect a considerable portion of white light as well as coloured, according as the surfaces are smooth, glossy, polished, rough or corrugated. Again, if silk, flax, jute, cotton, worsted, mohair, or woollen materials be dyed with exactly the same colour, the visible effect of each would be quite different because their respective absorbent and reflective powers are different.

Those who are familiar with Brussels and Wilton carpets know very well that both structures can be woven from the same set of cards and colours, but the visible effect of each scheme of colours is so different as to be unrecognisably the same. In the Wilton or velvet structure the colours appear deeper and more saturated than those in the Brussels which are keener, brighter and more decided in hue and tone. The reason for this is because the figuring *looped* threads of the Brussels have a *greater reflecting surface* than those of the 'cut' Wilton; consequently the former exhibits more light, whilst the latter disperses or breaks it up. At Fig. 26, Plate I, an illustration showing the above effects, is supplied. There are ten colours shown; first, each colour is woven with round wires leaving the pile in 'loop' form, and next, these same coloured threads are shown with the loops 'cut.' This is the only factor which accounts for the difference

in the tone or shade of every one of the ten colours. It cannot but be evident to every observer that the loop pile colours are brighter in hue and tone than the cut pile, the reason for which is embodied in the foregoing explanation. For the same reason a figured pile fabric, woven with certain portions of the pile threads cut while others are uncut, presents two distinct colours, though the pile material has been dyed with the same colour throughout.

Relative Proportions and Intensities.

Generally speaking colours which possess the greatest luminosity should have allotted to them the lesser portion of space, because they possess the inherent quality for neutralising greater masses of cold, neutral or semi-neutral colours. When colours are of the same height in hue or tone their masses may be approximately the same, but when the colour intensities vary, their masses should be apportioned to their relative intensities. Briefly the colours and masses must balance each other.

This is the explanation why a good combination of colours in large designs, when copied in the same colours but in a smaller pattern, is generally weak as a result. For the same reason when beautifully coloured natural objects are adapted to woven structures, great care should be taken to preserve the same balance of both mass and colour, otherwise the pleasing effect which characterised the natural object will be lost in reproduction.

Any colour scheme in which the ground is of a bright and luminous colour, always partially destroys the lesser luminosity possessed by the more subdued colours, hence it is almost always impossible to obtain a good combination of other colours upon a ground of excessive brightness, *e.g.* a small figure of yellow on a purple or black ground is preferable to black or purple on a yellow ground and similarly with red on a green ground.

Four styles in *greys* are supplied at Fig. 27, for the purpose of illustrating the principle of subduing the effect of increasing masses of any bright or luminous colour and thereby preserving the *respective* balance of their luminosities and masses. In this example equal quantities of black and white are first used in small quantities, then as their masses are increased, the tone of the white is lowered by

the addition of black so as to preserve the general balance of tone in each style.

A.	is arranged	1	unit of	Black	1	unit of	white.
B.	,, ,,	2	,, ,,	,,	2	,, ,,	light grey.
C.	,, ,,	4	,, ,,	,,	4	,, ,,	medium grey.
D.	,, ,,	6	,, ,,	,,	6	,, ,,	dark grey.

The same method of modification obtains when the pattern is ornamental and when colours other than black and white are used.

Juxtaposition. Perhaps one of the most remarkable things about colour, is that it is itself a modifier of colour. If two colours are placed contiguous, each will be changed in *hue* according to the colour with which it is associated. The first will be tinged with the complementary of the second, and the second with that of the first. Thus, when red and blue are placed in combination, the red becomes tinged with orange and the blue with green. Red when placed in contact with blue appears yellower, with yellow it appears bluer, with green purer and brighter, with black duller, and with white or grey brighter. Further, if the eye looks upon red until the colour appears dimmed and then is immediately directed to another colour, say white or yellow, the latter colour will appear to be inclined to green—the complementary of red. If a person examines several pieces of red cloth, the constant vision tends to make the last few pieces appear duller than those first seen. The eyes having dwelt on 'red' successively they desire to see 'green,' as a natural sequence. In order to avoid this illusion it is advisable to examine alternately red and green pieces,

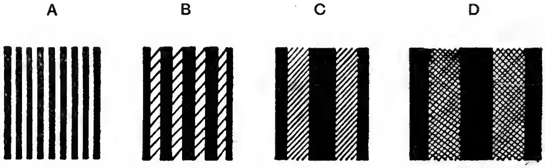


Fig. 27.

or to turn the eyes repeatedly towards a green coloured body, in which case the red pieces would appear to retain their uniform beauty.

It will therefore be evident that if the colour scheme of any carpet contains an excess of some bright colour, it will very soon grow wearisome to most people, hence, the most important factor in the colouring of carpets (as in most other things) is *balance*. From the foregoing it will be educed, that if one colour be placed in combination with any other colour or colours it will be changed in tone with each separate combination. This principle is most effectively illustrated at Fig. 28, Coloured Plate II, where are shown two portions of a six frame Brussels carpet, woven with the same design and colours. The design is a turn over, the same as Fig. 12. For convenience of comparison, only half the width of each carpet is shown—one the right side, the other the left. These were placed side by side and photographed for *each* fundamental colour; from these negatives the colour blocks have been made. In the actual carpet the visual difference of each colour on the two grounds is very considerable. The detailed examination supplied below is based on the visual changes seen in the carpets under the same illumination. These respective differences have to some extent been retained in the *reproduction*, a study of which should prove most instructive.

There are six colours in each carpet, five of which are in both, in fact they are woven off the same bobbins; the ground of each is the only colour which is different; the respective colours are:

1. Navy Blue Ground. 2. Normal Red Ground.
1 & 2. Deep Orange inclined to red.
1 & 2. Olive Green.
1 & 2. Smoke inclined to Dark Green.
1 & 2. Cream.
1 & 2. Drab inclined to Yellow Ochre.

Each of these colours when seen together upon the two ground colours, deep blue and red, appear very different in hue and frequently as different as when the same colour of a pile warp is viewed simultaneously as cut and uncut pile. In fact, unless it is

known that the colours are respectively identical it is difficult to convince any observer that they are from the same bobbins, but upon different ground colours. Since the yarns are respectively of the same hue, the effect is necessarily an optical illusion, but such an optical illusion, when the laws and principles of colour are well understood, may be turned to practical advantage.

In the illustration given, the orange brown appears upon the deep blue ground, more decided, purer, intenser and brighter. It has no irritating effect, but is pleasing and luminous. Upon the red ground it appears to suffer somewhat in intensity and brightness. Its hue is lowered and though the effect cannot be called bad, it is nevertheless inferior to the former. The explanation which may be assigned for this change of effect is that the blue ground adds its complementary 'orange' to the orange red colour, and thus makes it more orange, while the red ground adds its complementary 'green' and dilutes or lowers the tone of the orange red. Passing on to the olive green, we have a colour which may be generally described as harmonising since it usually looks well in most combinations. Upon the red ground the olive green is heightened in intensity, brightness and clearness, being due to the green which its contiguous colour, red, has added to it.

Upon the blue ground the olive green appears more subdued and would, as compared with the above, be allotted a lower position in any scale of hues in which green was a predominant factor.

The 'smoke' on the blue ground is more subdued and colder, whereas upon the red ground it has assumed a tone which is more inclined to green for obvious reasons.

The cream on the blue ground appears somewhat whiter than upon its contemporary red. The drab stands out in slightly greater relief and becomes more yellow upon the red than it does upon the blue ground. The explanation which appears to satisfy this condition is that this colour is chromatically just a little further removed from the red than the blue. These changes as already expressed, and as will be readily perceived, are simply *optical illusions*, but are of great practical value, therefore every producer of woven fabrics in which colour enters as a factor, would be well repaid if he

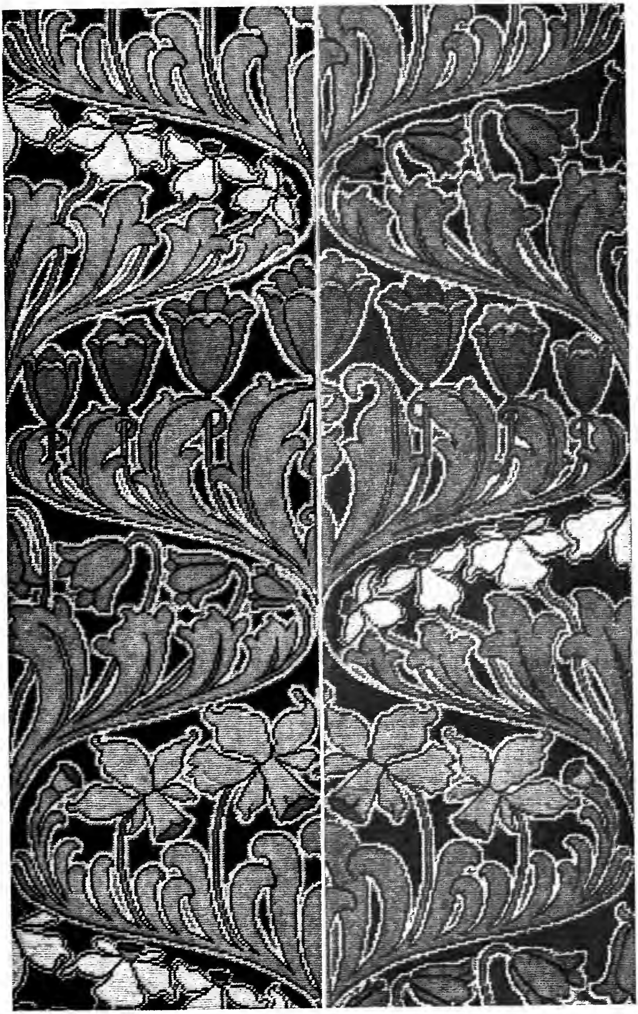


Fig. 28.

PLATE II

made a specific study of this branch of his work, apart from the great interest which he would experience in his observations and experiments.

Harmonious Colouring.

Harmonious colouring is perhaps the most important feature in this chapter. A combination of colours may be described as *harmonious* when it produces not only a positively pleasing effect but when it is characterised by an absence of want, a definition which coincides with that of health appropriately described as that state of the body in which all the functions of it go on without notice or observation, when it is a pleasure to see, to hear, to feel, to live. Though harmony of colours is intricate, yet some of its general principles may be indicated.

In the production of harmony three kinds may be considered.

1. Harmony by Contrast.
2. ,, ,, Analogy.
3. ,, ,, Gradation.

Harmony by Contrast.

Contrast of colour is that principle or quality which produces a visual change of lustre, depth, saturation, and hue or tone when two colours are contiguous. There is contrast when two colours, which are contiguous so influence each other as to make one appear darker and the other lighter in shade than they actually are, *e.g.* black contiguous with white appears deeper and more thoroughly saturated, whilst the white is whiter and brighter. (See also juxtaposition).

In the production of harmony by contrast the complementary assortment is superior to every other, and what applies to complementary colours in the production of harmony, applies in a corresponding yet lesser degree, to contrasting colours. Harmony is however only attainable when the contiguous colours are of equal height in tone, or nearly so, and when combined in suitable proportions and with due regard to their relative intensities. When the respective shades are of equal depth in hue, etc., the quantities may be uniform and be used only to such an extent as to impart precision

to the leading features of the design. The colours should be distributed in such a manner as to give value to every part of the fabric, not only in each particular object, but also in the union of each object forming a single composition. When the greatest brilliancy is desired complementary colours should be employed, and as a rule the stronger and more intense the colours are, the greater is the skill required in their association with other colours, but whenever opportunity admits, the most vivid and contrasting colours may be advantageously employed. Anyone familiar with the laws of contrast will be able to produce results, even with inferior colours, much better than another person who, although possessed of the most brilliant faculty of selection, is ignorant of such laws.

Contrasts by pure or primary colours are harsh and irritating, *e.g.* red and blue form a strong contrast but if these be subdued by mixing with black or white they yield a softer and mellower effect. If the contrasting colours differ much in strength, the feebler always appear either more whitish or greyish or assume the complementary tint, while the stronger always appear more intense. The juxtaposition of strong with feeble colours inevitably results in an alteration somewhat injurious to the latter. Relatively considered, contrast in hues are most extensively and preferably used in carpets and where large masses of figure combined with brilliancy of effect are required, because they produce more brilliant contrasts than either tones or tints. As a matter of fact if the hues are strong and the mass is small, they usually produce a bad grey, owing to the great difficulty of balancing the amount of each colour for the various parts of the design, though in a general sense tones and tints constitute the bulk of colouring for weaving purposes.

Harmony by Analogy.

This may be defined as the principle of amalgamating mono-chromatic colours, *i.e.* the juxtaposition of two or more colours belonging to the same scale of colour or to some scale approximating. This system is extensively applied to all classes of woven fabrics especially carpets and upholstery.

While colours, as a rule, which are nearly identical become less

intense or saturated by juxtaposition, there are many examples, where two colours closely related chromatically, may without detriment be placed contiguous, *e.g.* when two colours express different degrees of luminosity of one and the same surface, the result is a higher illumination of a single coloured surface and many such examples are to be found in both nature and art; thus, when the sun is shining, the green grass which is in the shade, appears darker than the same shade of grass on which the full rays of the sun fall for the time being, yet the result cannot be said to be inharmonious, because the effect is *natural* and *reasonable.*

Velvet and loop pile, or two *different* figuring materials dyed the same colour are also examples to wit.

Nature often employs different substances in the production of harmony, and so whenever two colours have their luminosities arranged so as to correspond with nature, the resultant effect may always be expected to be satisfactory.

Harmony by Gradation.

Gradation is very much akin to the foregoing analogous combinations; it may be described as the arrangement of colours which pass into each other by gentle and insensible steps so that it is almost impossible to distinguish where any one colour has its beginning or ending; the best example is the rainbow or spectrum. Gradation always tends to resist the influences of harmful contrasts. It imparts to the mind a sense of richness and always seems to carry the eye forward as though there was something more to see. It furnishes one of the great sources of beauty. In nature the endless variety of variation by gradation is most remarkable; the glory of the rose and many other flowers lies in their gradation and variety of tints. It is for this reason that the best colourists strive more and more to introduce it into their schemes of colouring; they rely more upon this principle than upon contrast. It is mainly because of the endless variety of variation in some of the past masterpieces that reproduction is rendered most difficult. It should be noted, however, that gradation lends itself more to realistic representation rather than to conventional or distinctive ornament. Observation will also reveal that most artists keep their colours

together in large masses—the bright but graded warm colours in one place and the cool pale tints in another. Further the appearance of colour depends greatly on gradation; uniform colouring appearing hard and disagreeable, when gently varied may become pleasing as well as truer to nature. Gradation of colour is almost universally employed in nature and educationally a study of it is important if not essential. Skill in the art of gradation gives the colourist great power to manage large masses of nearly uniform colours, as well as considerable control over colour combinations which inherently are of doubtful value.

Inharmonious Combinations Modified.

When two colours in juxtaposition produce a harsh contrast, harmony may often be obtained by introducing a third colour as a harmonising medium, *i.e.* a colour which will agreeably assort with either colour. The following observations are selected from the best productions of woven carpets.—Masses of red and orange yellow are outlined with green, consequently the two colours which would otherwise produce a harsh contrast have been brought into harmonious combination; when blue and green are contiguous they tend to injure each other, but if assorted with orange or gold as follows:—blue, gold, green, gold, the combination is preferable because gold will combine agreeably with either blue or green; masses of dark green and light red have been improved by an outline of cream; deep green and light yellow masses of figure find a harmonising medium in light blue of the same height as the yellow. Even when contrasting colours are blended in masses a third colour is sometimes introduced with useful effect. Thus purple and yellow assorted in masses will suffer no injury, but in some cases be improved, by a divisional line of black. Upon the same principle black or white may be advantageously employed—white assorts best with cold and retiring colours, whereas black may be made a harmonising medium for all colours, especially the luminous, since it gives brilliancy to them by its sedative effect on the eye and its power of contrast. It heightens 'warm' as well as light colours and in like manner subdues deep colours. In association with sombre and broken tones of luminous colours

it produces harmony of analogy. This method is most extensively followed by all artists and colourists of high class and variously coloured productions, though variety in colour, like every other principle, should never be carried too far; whenever objects must have a certain superficial extent, nothing is gained by multiplying varieties of them; thus, the repetition of three colours including white or black, will generally be more agreeable than that of an arrangement of five colours. The several colours should be distributed in such a manner as to give value to every part of the fabric—not only in each particular object but also in the union of each object forming a single composition and no composition of colours is perfect which does not include all the primaries either in their natural or compound state.

Concluding Notes.

The chief province of colour is to brighten and improve the appearance of woven fabrics. 'Form' is only secondary as compared with it; this is due, in part, to the fact that many forms can only be imperfectly expressed and in the cheaper fabrics only approximately represented or even suggested, and further the actual pattern is always distorted, due to foreshortenings and part coverings by the furniture; besides, frequently the colour scheme is first decided upon, by arranging tufts of yarn, as flowers are often placed in combination, after which the form is designed to display these effects.

'Colour' in a sunset is only of importance, 'form' is never considered.

If then, it is important for the artist to study the laws and principles of colour, it is much more so for the person who has to produce beautifully coloured effects and imitate given objects in woven textures by the combination of variously coloured threads; especially is this the case in respect to Axminster and Tapestry carpets, where it is very difficult to rectify any initial faults, as compared with any errors on the canvas of the artist.

Though a person may get along without a knowledge of the principles of harmony, yet it would be a mistake to suppose that he

can remain ignorant without disadvantage to himself, since the production of the best possible effects is incumbent on each designer. In any desire to excel, no better guide can be followed than the laws which underlie the first principles of colour and colour combinations, which principles it has been the purpose of the author within the brief space at his disposal, to demonstrate.

The study of the appearance of coloured bodies, based on positive facts, leads to a certainty which all may acquire, who give themselves up to it.

While many designers and manufacturers are guided and influenced largely by fashion in their productions, yet, if they have been well instructed and are masters of colour principles, they will in turn guide and influence fashion in the right direction.

Lectures and literature can do little more for the colourist, than present the principles underlying the science of colour. The application of these principles will rest with his own skill and faculties; in the exercise there will be liberty of action for all, though not perhaps equality of powers, for genius and talent are Divine gifts, except so far as they are the reward of acquired skill and industry.

CHAPTER III.

Brussels Carpets.

General Particulars.

Introduction of Brussels Loom.

The first Brussels Carpet Loom made in this country was completed, with the aid of a Belgian weaver, rather more than a century and a half ago —1749-50, since which advent the production as well as the demand for Brussels carpets has constantly increased in volume. The small market and manufacturing town of Wilton in Wiltshire claims the distinction of having first made these carpets in England and a Kidderminster manufacturer is reputed to have introduced the Belgian weaver with whose assistance the first Brussels loom was constructed and the manufacture of carpets bearing this name assured.

Classification.

A Brussels carpet belongs to the pile class of woven fabrics; it consists of a strong and durable textile foundation, upon the base of which is interwoven and displayed a figured pattern of differently coloured loop threads made from long and coarse fibres of wool on the worsted principle of manipulation. The character of the fabric permits of definiteness and smartness in design and colour for which these carpets are noted. As regards cost in production it is economical in the operation of dyeing but comparatively expensive in weaving as well as in the quantity of figuring or costly material used, in comparison with the actual amount displayed on the surface. It is nevertheless about the best and most durable of the *loop* pile class of carpets.

These figuring threads represent its chief feature; in the cheaper kinds they are made in two and three sets of colours only, but they are usually made in sets of four or five colours. Each set is technically called a 'frame,' occasionally six frames or sets of colours are used and sometimes small sections of other colours, at

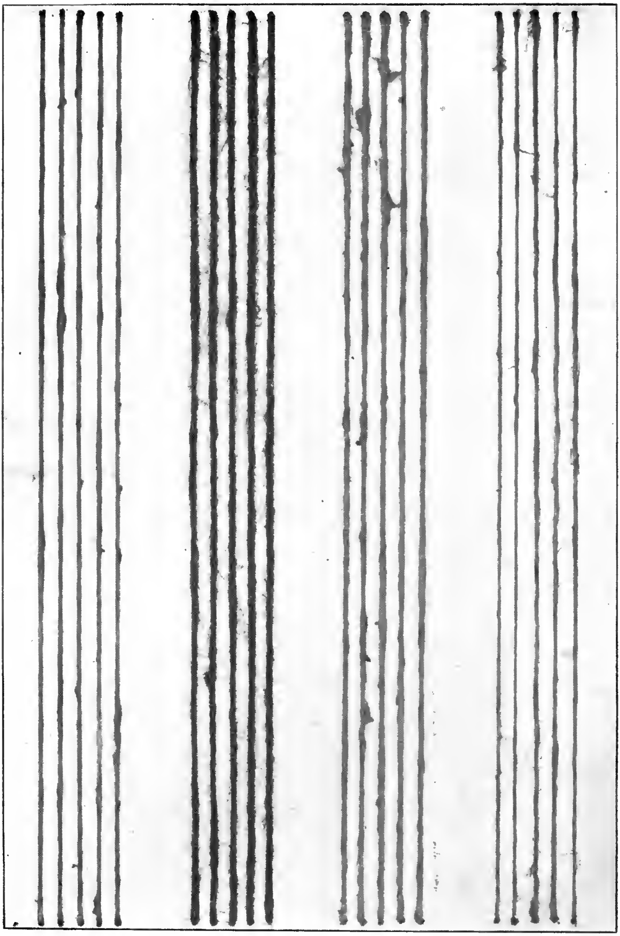
intervals across the width of warp, are introduced for the purpose of producing variety. These replace an *equal number* of any one or more sets of colours. This method which is called 'planting' will be described fully later. Each thread is of a distinct shade throughout its entire length, according to the frame or plant colour to which it belongs. This is the factor which permits of the production of a perfectly sharp and distinct pattern.

Generally all the figuring or pile threads are not displayed on the surface simultaneously—only so many as are equal to the number contained in one frame, but the coloured threads are selected from one, more or all the frames in accordance with the colours in the pattern required. All the remaining pile threads are stowed away in the body of the texture until they are again required for figuring purposes. It is this factor which adds considerably to the expense in production, but even this factor is not without its redeeming qualities since it increases the carpet in bulk, loftiness and springiness.

The quality of a Brussels carpet depends chiefly on the number of frames used together with the number of 'points' or loops per square inch. The full capacity of the jacquard machine permits of 264 figuring threads being raised to form the loops on the surface in the full $\frac{3}{4}$ width of carpet, and the structure of the fabric will admit of the insertion of about 10 wires per inch so that the very best Brussels would contain (10×10) 100 points per square inch; but in all the better class qualities of five and six frames there are usually 256 points in a $\frac{3}{4}$ width of reed and 9 to 10 wires per inch in length of piece—all other qualities below 256 points are called 'stouts.' For cheaper carpets a reduction of from 30 to 40 loops is generally adopted; a second quality usually contains 234 loops in $\frac{3}{4}$ yard width and about 8 to 9 wires per inch in length of piece; a third quality contains 216 points per $\frac{3}{4}$ yard width and 7 to 8 wires per inch.

Materials and Structure. A photograph actual size of the different materials used in the production of a Brussels carpet is shown at Fig. 29.

A is a 3/21 cotton warp thread—used for the small chain.



A B C D

Fig. 29.

PLATE E.

B is a 3/2/16 worsted warp thread—used for the figuring warp.
C is a 14 spindle (Aberdeen) jute warp thread—used for the stuffer chain
D is a 5 linen or flax weft thread—used for the filling.

A cross section through the weft of a *three* frame Brussels is shown at Fig. 30. This will serve to illustrate the composition and construction of these fabrics.

A represents the small chain.
B1, 2 and 3 represent the figuring warps in frames 1, 2 and 3 respectively.
C1 and 2 represent the stuffer chain.
D represents the filling.

Fig. 30.

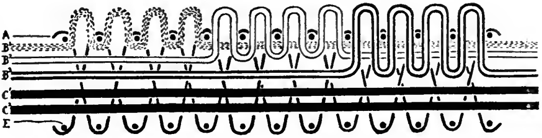


Fig. 31. Fig. 32.

Figs. 31 and 32 show cross sections through the weft and warp respectively of the foundation cloth exclusively; the same letters in each of the three diagrams refer to similar threads.

Fig. 33 is a line diagram showing a vertical section through the healds, harness board and reed, together with a cross section through the weft of a six frame Brussels carpet containing one stuffer. The passage of the respective warp threads through the mails of the healds and harness to their relative positions in the fabric are also illustrated. The letters A B C D refer, as in Fig. 30, to the small chain, figuring and stuffer warps and filling respectively. The harness cords 1 2 3 4 5 and 6 carry figuring threads from frames 1 2 3 4 5 and 6 respectively; these pass through the movable comberboard J and support the mail K.

The weight L is called the lingoe and serves to bring the harness cord back into its normal and lowest position after having

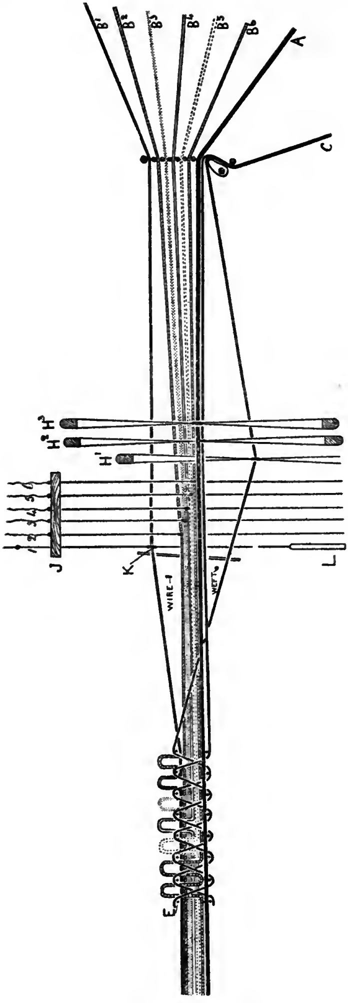


Fig. 33.

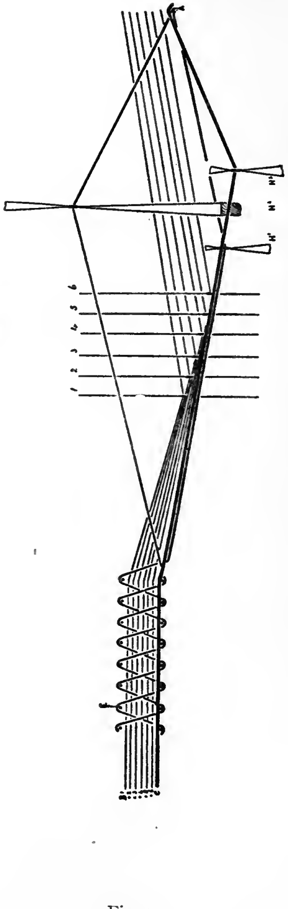


Fig. 34.

been elevated by the jacquard machine. The signs H[1], H[2] and H[3] refer to the heald shafts, the first and second control the small chain and the third supports the stuffer warp. Healds H[1] and H[2] are controlled by independent shedding mechanism, but heald H[3] is securely fastened to the comberboard J and is consequently elevated and depressed with it. The small chain and stuffer warp threads are contained on separate warp beams from which they are passed forward to and through the mails of three heald shafts as described.

Each figuring thread is on a separate bobbin so that it can be drawn forward by the pull of the carpet already woven, tensioned independently by a small weight or individually elevated by its respective cord in the jacquard machine.

In each split and repeat of warping and drafting plan there are:—

(1) Two threads of small chain.

(2) One or more stuffer threads according to the number required.

(3) As many figuring threads as there are frames in use.

These represent one row of pile or loops.

The number of such rows of pile across the full width of the carpet coincides with the number of splits or dents in the reed used and the number of threads in a frame.

The standard width of the carpet is 27 inches; the width of the warp in the reed required to produce this is 28 inches; and the maximum number of splits *used* in this width is 260. Four shots of filling and two wires are required to complete the weave structure. This is technically spoken of as 'two shots to one wire.' There are two warp sheds—the ground and the figuring; the ground shed is produced by mechanism which operates on the heald shafts. Into this shed the weft filling is inserted which helps to form the base structure. The figuring shed is formed simultaneously with each alternate shed of ground but independently and distinctly above it. Into this figuring shed wires are inserted so as to form the pile surface.

The following is a detailed description of the warp shedding for one complete repeat of the weave structure.

First Pick—Single shed.

Lift heald No. 1 which carries all the odd threads in the small chain. Insert shuttle with the filling weft; see Fig. 34 which shows the *single* shed only.

Second Pick—Double shed.

Lift heald No. 1, comberboard J with all figuring threads and heald No. 3 with all the stuffer threads to form the bottom shed. Simultaneously the jacquard machine selects, through the medium of cards and needles, all those harness cords which carry the pile threads required to form the figure on this row of loops and raises them so as to produce a *second* division of warp threads immediately above the bottom shed. The shuttle is now inserted into the bottom shed whence it passes over all the *even* threads of small chain and *under* all the *figuring* and *stuffer* threads and *odd* threads of small chain. At the same time the pile wire is inserted into the upper shed under the selected figuring threads (one sixth of the pile threads) and over all the rest; see Fig. 33.

Third Pick—Single shed.

Elevate heald No. 2 which carries all the even threads then read as for No. 1 pick.

Fourth Pick—Double shed.

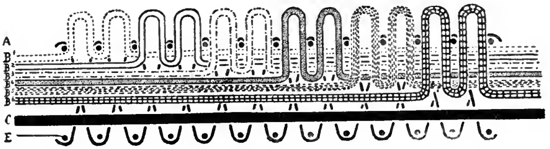
Elevate heald No. 2 and then read as for No. 2 pick.

Before the introduction of the modern Brussels loom and the apparatus for forming the *double shed*, it was necessary to make six separate and successive sheds for every complete repeat of the weave structure, viz:—four for the base structure and two for the figuring.

Usually the jacquard machine lifts on any given figuring pick a complete *set* of colours made up from one, more or all the frames in use, the remaining colours at that particular point lie buried in the centre of the base structure, *e.g.* with two frames, $\frac{1}{2}$ the worsted is used for the figure whilst the other is buried in the fabric; with three frames, $\frac{1}{3}$ is available for figuring and $\frac{2}{3}$ remain in the foundation; with four frames, $\frac{1}{4}$ is used for the loops and $\frac{3}{4}$ are in the centre of the base structure; with five frames, $\frac{1}{5}$ is used for figuring and $\frac{4}{5}$ for stuffing; with six frames, $\frac{1}{6}$ is displayed on the surface as pile and figure and $\frac{5}{6}$ is stowed away in the heart of the fabric, as at Figs. 36 and 36A.

Figs. 35 & 36 represent vertical sections of the carpet through the warp. The former shows all the pile warp embedded in the middle of the carpet, between the top and bottom picks. This is what actually occurs on every *single* pick in each carpet irrespective of the *number* of frames employed. In the latter figure $\frac{1}{6}$ of the pile threads in each vertical row of pile is selected from one or other frame of colour and then raised above the pile wire into the position as indicated, *e.g.* in the first vertical row starting with the right

Fig. 36A.



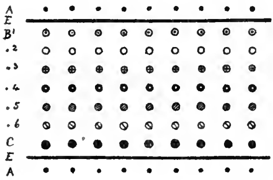


Fig. 35.

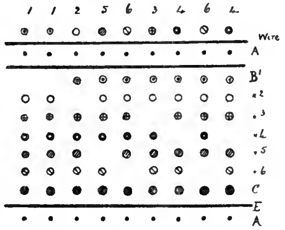


Fig. 36.

hand, a coloured thread from the fourth frame has been selected and elevated above the pile wire. In the second, third and fourth vertical rows, colours have been selected from the sixth, fourth and third frames respectively; continuing, the reader may easily trace out the other selected colours to the end of the diagram. A cross section through the weft of Fig. 36 is shown at Fig. 36A.

The same letters in each illustration from Fig. 29 to 36A inclusive refer to corresponding threads.

The Brussels Loom—Mechanism and Construction.

A photograph of a modern Brussels carpet loom minus the jaquard and frame is shown at Fig. 37. It is a view in perspective of the front of the loom together with the driving of same, high wire motion, gantry for supporting the jacquard machine, the heald levers and connecting rods for same, part of the taking-up motion and at the remote left hand corner a small portion of the letting-off mechanism. This illustration should prove very helpful to a study of the several line diagrams which follow, inasmuch as by it, the *relative* positions of the several parts subsequently described in detail will be readily located. The letters and numbers in this figure refer to corresponding parts in the line diagrams related to it.

To prepare designs for Brussels carpets, successfully colour them, overcome any limitations and fully develop all the possibilities, involves a thorough understanding of the mechanism of the loom its accessories and movements. A progressive knowledge of this subject will be gained by a consideration of the following subdivisions in order :—

1. Driving mechanism and speed of the loom.
2. Jacquard Machine, harness mounting and healds.
3. Ground and figure shedding mechanisms—Tappets and Jacquard.
4. Picking.
5. Wire motion.
6. Beating up the weft and wires—Double beat.
7. Letting off the warp and figuring threads.
8. Taking up the carpet—Positive.
9. Stop rod, weft fork and knocking off motion.

Driving Mechanism.

The average speed of a Brussels carpet loom is 60 picks or shots of weft per minute, sometimes expressed as 30 wires. The system of driving may be defined as compound and parallel; compound because the method of driving is indirect and parallel since all the driving and driven shafts are parallel.

The aim of compound driving is to first generate a high rate of velocity in a supplementary shaft, based on the theory that any

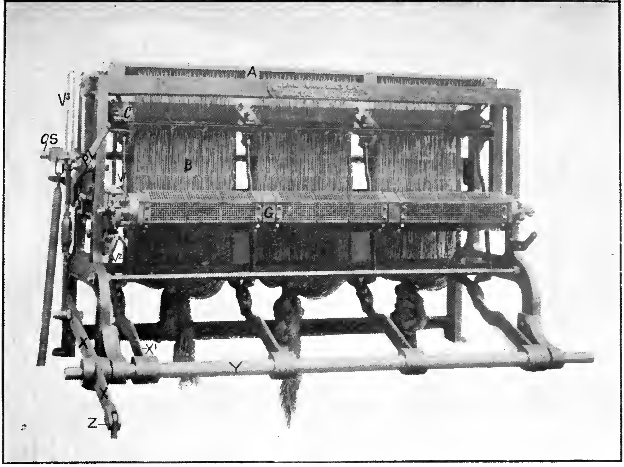


Fig. 39.

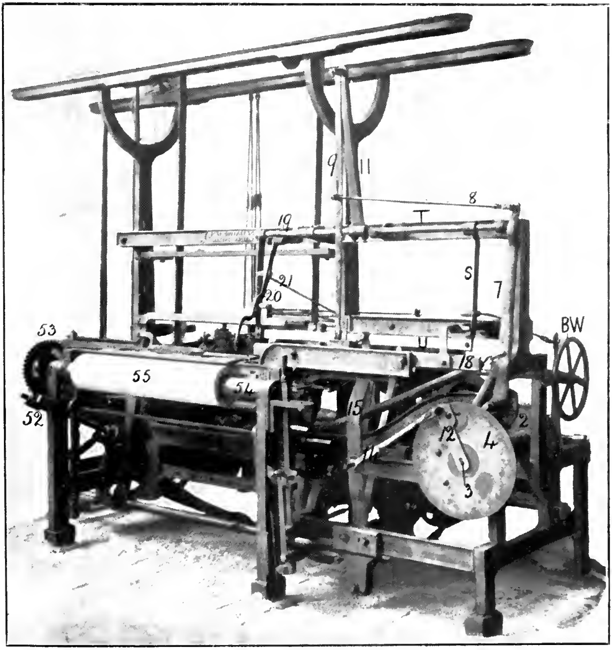


Fig. 37.

PLATE F.

increase in velocity carries with it a greater uniformity of motion, which also assists the machine to negotiate or tide over any part of motion which requires a relatively greater power. The required reduced speed of the main loom or crank shaft is then obtained by toothed gearing, which to a considerable extent retains the momentum and regularity of running already generated by the higher rate of speed just described. In the manufacture of Brussels carpets and other similar goods a very considerable amount of power is required to assist the 'going part' to beat up the weft and wires into the structure. With the object of assisting the loom to perform this work thoroughly an arrangement is added to the compound system of driving which enables the 'going part' to beat *twice* against the carpet for each insertion of weft and wire and revolution of the crank shaft. The 'double beat' is described under the heading of beating up the weft.

A line diagram at Fig. 38, which taken as a whole represents the end section of the 'cradle' or high wire motion, also illustrates the system of driving. Let A and B represent the mill shaft and drum respectively; they are not shown in the illustration but their places will be readily realised from the position of the driving strap; C indicates the driven pulley on the supplementary shaft D; BW is a balance wheel; on the same shaft a small pinion wheel E gears into and drives a larger spur wheel F, which is securely fastened to the crank shaft G; on the same shaft G is a spur wheel H which gears into and drives a spur wheel K, securely keyed to the picking or bottom shaft L. A small spur wheel is cast with the spur wheel H and is required when changing from Brussels to Wilton carpets, but if necessary could be separate from it as in the diagram.

Without entering into any lengthy discussion of the principles and solutions of driving problems, let the following actual particulars form the basis of one calculation.

Speed of mill shaft—120 revolutions per minute; diameter of drum B, 32 inches; diameter of pulley C, 12 inches; No. of teeth in pinion wheel E, 20; in spur wheel F, 110; in spur wheel H, 48; and in spur wheel K, 96 teeth. Find the speed of the crank shaft G and

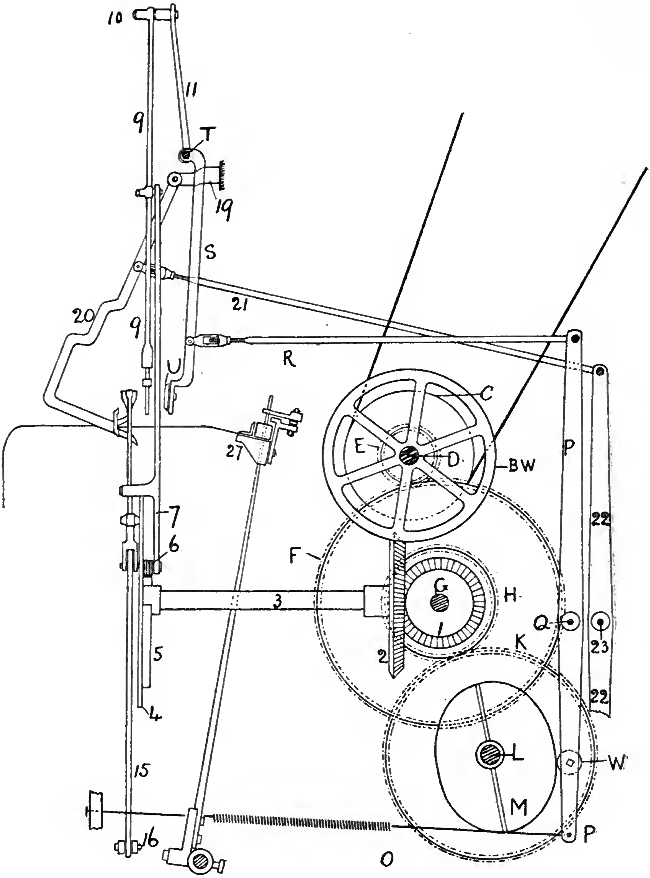

10
11
9
T
19
S
21
20
9
R
U
C
27
E
D
BW
P
22
7
6
F
G
H
3
Q
23
K
5
2
22
4
L
W
15
M
16
P
O

Fig. 38

the low shaft L. Then without discussing the theory of solution, it may be simply stated that the speed of the crank shaft G may be found by simply dividing the product of all the driving factors by the product of all driven thus :—

$$\frac{A \times B \times E}{C \times F} = \text{Revs. of G per min.} = \frac{120 \times 32 \times 20}{12 \times 110} = 58{\cdot}2 = \text{Speed of Crank Shaft.}$$

and similarly for low shaft L.

$$\frac{G \times H}{K} = L = \frac{58{\cdot}2 \times 48}{96} = 29{\cdot}1 = \begin{array}{l}\text{Revolutions per minute.}\\ \text{or No. of Wires.}\end{array}$$

The Jacquard Machine and Harness Mounting.

Fig. 39 is a photograph of a five frame modern Brussels Jacquard machine. The letters in this illustration refer to corresponding parts detailed in connection with Figs. 40 and 41.

A jacquard machine is a combination of mechanism and mounting, designed for the purpose of enabling the manufacturer to produce a considerable variety of 'warp sheds' and consequently a large repeat of pattern, with the greatest possible ease and the minimum amount of floor space and expense.

A diagram at Fig. 40 shows the essential parts of a six frame Brussels carpet jacquard together with the harness mounting. The illustration is an end view of the suspension board, needles, guide and comberboards, harness cords and lingoes. A represents the top stationary board from which all the harness cords are suspended; B, the harness cords which pass through perforations in the board C which is free to move in a vertical plane; the perforations consist of large and small holes joined by a narrow passage. Strictly speaking the small holes are simply slits or continuations of narrow passages, countersunk at their terminations so as to receive the knots in the harness cord without exercising any undue harshness upon them. Their arrangement and character are illustrated at Fig. 41. The harness cords B are knotted just above these holes and with a knot to admit of their passage through the large but not the small holes. Immediately below this lifting board is a set of cross wires D, commonly called needles. These are supported in the positions shown by the two iron plates E and F; each needle is free to move in a horizontal plane and has two loops or eyes through

each of which a separate harness cord passes and in the order as shown. Sections of the card cylinder and striking up or levelling board are shown at G and H respectively. The harness cords now

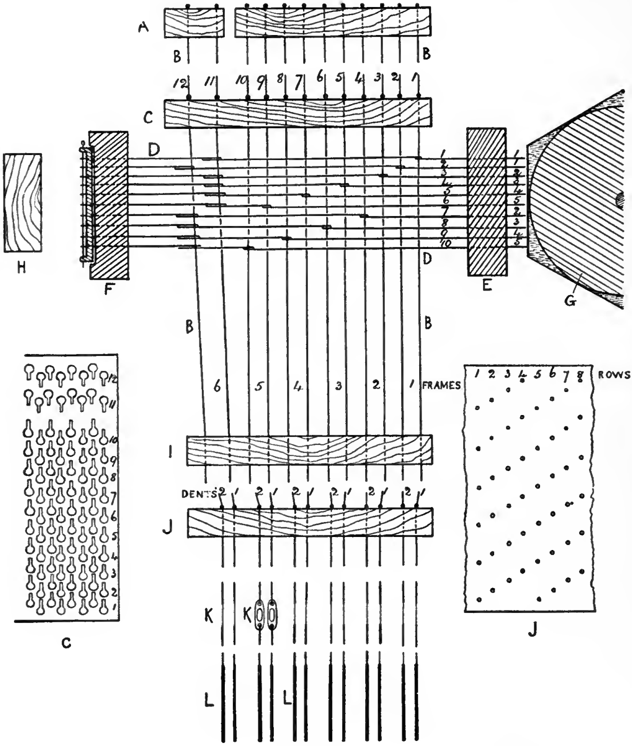


Fig. 41. Fig. 40. Fig. 42.

pass through a perforated board I which serves the purpose only of a guide to them and then through a lower perforated board J. The board J measures eight inches from front to back and the holes are

arranged diagonally as in the plan at Fig. 42 in order to allow the harness cords with mails, warp and lingoes sufficient room to operate without overcrowding. All the harness cords are also knotted just above this board J which is free to move in a vertical plane and can therefore, when elevated, lift all the harness cords at one time. The mails and lingoes are seen at K and L respectively. The figuring threads pass through these harness mails only.

In the *top* lifting board C, Figs. 40 and 41, there are twelve holes from front to back; the last two holes are set diametrically opposite to those of the first ten. There are twelve harness cords in each row of this board.

In the *bottom* lifting board J, Figs. 40 and 42, there are six holes from front to back. The harness cords from every row of holes on board C occupy two rows of holes on board J.

Each harness cord in the board J from front to back controls one thread belonging to each frame; these all go together with two of small chain and one stuffer into one dent or split and form one row of pile.

The harness cords are consecutively numbered above the lifting board C; the frames of colour to which each belong are indicated below, and the rows of needles and corresponding holes in cards and card cylinder are consecutively numbered at the side from the top downwards as shown in the illustration.

The knots in the cord of the first ten rows, when in their normal position are immediately over the large holes, whereas the knots in cords of rows 11 and 12 are just above the small holes. Then whenever the top board C rises, all the harness cords belonging to the sixth frame are lifted, whereas all the remaining cords and corresponding threads belonging to the first five frames are left down, unless the cords are externally controlled.

The numbers between E and G indicate the frames of colour which each respective needle controls. The cross wires or needles D control harness cords 1 to 10 by a small round hole, just large enough in diameter to permit the passage of the cord, but a long narrow slot is formed in the wires where the harness cords 11 and 12 go through them; this is because these harness cords each pass

through five separate wires and by having a long slot it is possible to move one of the cross wires with the cord without in any way interfering with any of the other four needles.

The needles D are so connected with the harness cords that, whenever the knot of a lifting cord belonging to any one of the first five frames is pressed, by its respective needle, from being over the larger hole to a position immediately above the smaller hole, it simultaneously presses the harness cord belonging to the sixth frame and the corresponding dent, from over the small hole to a position immediately above the large hole. Consequently when the board C *rises* it takes up the selected cord and colours belonging to any of frames 1, 2, 3, 4 or 5 but it leaves down the cord and colour belonging to the sixth frame and corresponding dent.

The small chain or cotton warp for ground and the stuffer threads are controlled by three heald shafts placed immediately behind the figuring harness. Two of these heald shafts carry the small chain and are worked independently of the jacquard by means of positive tappets to be described; the third shaft carries the stuffer threads and is securely fastened to the lower comberboard J, both of which are elevated by means of a tappet on the low shaft and suitable levers.

Shedding Mechanism-Healds.

The healds are worked on the 'positive shedding' principle, the 'Woodcroft tappet' system being largely adopted for this purpose. This mechanism is designed to elevate and depress the healds without the aid of external parts such as over or undermotions; the chief features of the mechanism and its connection with the healds are shown at Figs. 43 and 44. The former represents an end section and the latter a front view of the healds with the harness removed. The letters in each illustration refer to corresponding parts. A small pinion spur wheel M with 30 teeth is securely fastened to the crank shaft and gears into and drives a large spur wheel N having 120 teeth. To this wheel, which is sometimes called the tappet wheel, all the disc plates DP with tappets O are secured; the wheel N together with the tappets O are on a barrel which is *free* to revolve around the low shaft. A treadle lever P with its fulcrum at Q

supports an antifriction roller R which rests against the tappet O^1 as shown. The free end of the treadle lever P is connected with the top of heald H^1 through the medium of connecting rod and jack lever S^1 and also with the bottom of the same heald shaft, through the medium of connecting and bottom lever T^1. It will also be observed that heald No. 2 is also similarly connected to its respective tappet

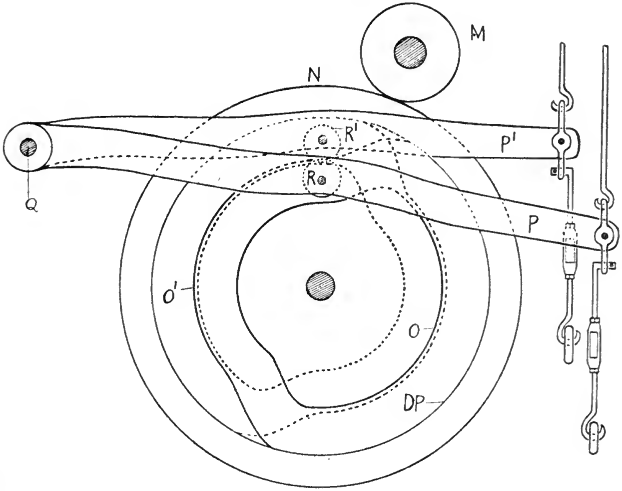


Fig. 43.

through treadle P^1 and bowl R^1. The chief feature of this mechanism is the 'tappet;' it consists of a disc plate DP which has two raised narrow surfaces on one side or face with a space between to allow of sufficient play for an antifriction bowl. These surfaces or projections are similar in shape to ordinary tappets but designed so as to impart, through suitable connections, movements of elevation and depression to the healds. The construction of the inner projection O is identical

in principle with the ordinary negative tappet, but the outer projection o[1] is concentric only and parallel with the *variable* parts and the *smallest* diameter of the inner raised surface o. The outer formation is therefore a duplicate in variation and construction of the inner

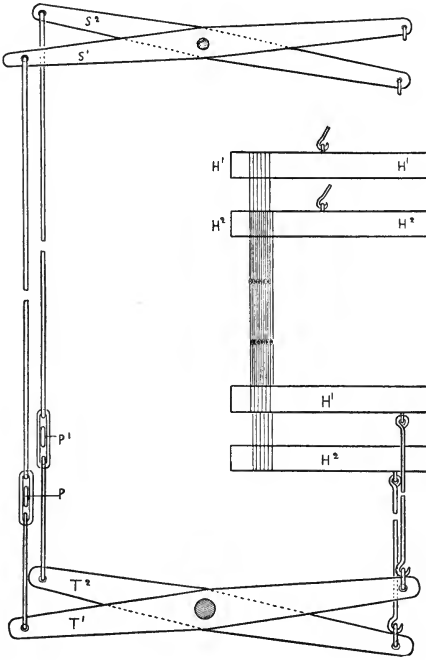


Fig. 44.

formation. A groove is thus formed through which the treadle or anti-friction bowl can travel, but the space is generally arranged to be from $\frac{1}{8}$ of an inch greater than the diameter of the treadle bowl so as to prevent any locking. The inner projection o of the tappet

elevates the treadle bowl R together with the treadle lever P, and these through the connections shown and described in Figs. 43 and 44 depress the heald shaft H^1. The outer projection O^1 operates in turn upon the uppermost side of the treadle bowl R and so produces, through connections illustrated, an elevation of heald shaft H^1.

In a similar way the heald shaft H^2 is controlled by a second tappet immediately behind O, which in turn operates upon the treadle bowl R^1 and treadle lever P^1—these through their respective connections elevate and depress the heald shaft H^2. Since the number of teeth in the spur wheel M is just one fourth of those in spur wheel N, the latter makes one revolution every four picks. The tappet O is therefore constructed to elevate and keep the shaft H^1 up for two picks, but as O allows H^1 to fall, O^1 commences through its connections to elevate the shaft H^2 and keeps the same up for two picks.

Shedding Mechanism-Jacquard.

The mechanism which actuates the harness lifting board C, the card cylinder G and back needle levelling board H is illustrated at Fig. 45. To the low shaft L, a tappet O^2 is securely keyed in the position shown. An antifriction roller R^2 supported in the treadle lever P^2, fulcrumed as shown, is kept in rolling contact with the tappet O^2; at the free end of P^2, a loose stud U connects the lifting rod V with P^2; the top end of this rod is connected by a stud W with the lever X; lever X is securely fastened to the shaft Y; at the free end of the lever X a counterpoise weight CW is suspended from the position Z; a second lever X^1 is fastened to the shaft Y; two upright arms V^1 and V^2 connect lever X^1 with the harness lifting board C. The shaft Y passes along the front of the jacquard machine in the position indicated. There are four such arms as X^1 on shaft Y with uprights corresponding to V^1 and V^2 to support and move the lifting board C, see Fig. 39. To the lever X at the position W^1 an adjustable lifting rod V^3 is connected. The upper end of V^3 contains a long slot through which the free end of a simple lever SL passes; this lever is securely fastened to the shaft O S, which is supported by two small brackets, one at each end of the jacquard frame and is free to oscillate about its own centre. To this shaft a vertical lever VL connects a sliding bar SB which is supported and free to move through slot

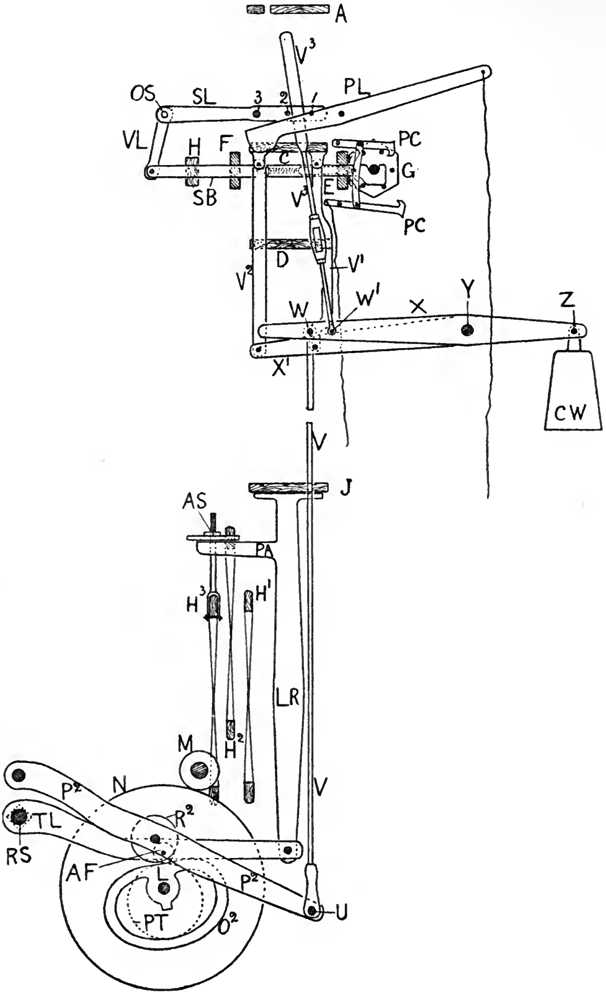

A
OS
SL
3
2
1
PL
VL
H
F
C
PC
G
SB
E
PC
D
V'
W
W'
X
Y
Z
X'
CW
V
J
AS
PA
LR
M
N
TL
RS
AF
L
U
PT

Fig. 45.

guides in the iron plates E and F. One end of SB supports the card cylinder G, while the opposite end supports and moves the back needle 'levelling' board H.

In the lever SL there are three projecting studs indicated under the numbers 1, 2, 3. The first two act as a guide in keeping the upright rod V^3 in position; the stud 3 projects over the simple lever PL fulcrumed as shown. Suspended from the long arm of this lever is a string which the weaver pulls when the card cylinder G has to be clear of the needles and thereby in a position to turn the cards backwards or forwards at will, by hand; *e.g.*, if the string be pulled downwards the longer arm of the lever PL descends but the shorter rises and presses against the stud 3 and thus elevates SL and turns shaft OS counter-clockwise. This shaft O S moves through the lever VL, the bar SB together with the board H and cylinder G in a direction to the right until the card cylinder is perfectly clear of the needles; in this position it can be made to revolve in either direction according to the position of the top or bottom catch PC. A strong spiral spring is fastened to the lever SL slightly to the left of stud 3; it is suspended and made fast to one of the jacquard supports and serves the purpose of bringing lever SL (after having been elevated by rod V^3) into its lowest and normal position, against a bracket casting, not shown in the illustration, but immediately under SL and at a point about $\frac{1}{3}$ the distance from stud 3 in the direction OS. The object of this bracket is to arrest and limit the fall of SL and so regulate the oscillation of shaft OS and the throw of VL, thus preventing any undue pressure of the cards and card cylinder against the needles.

The oscillating shaft O S passes behind the jacquard in the position indicated and operates on parts of mechanism corresponding with VL, SB, G and H at the opposite end of the jacquard.

It has been previously shown that the low shaft makes one revolution to every two picks and that the figuring is required to be formed once in every two picks; the tappet O^2 is constructed to elevate the harness lifting board C and keep it up during the period of one pick, and also to permit it to fall and remain down during the period of one pick. This it accomplishes

during one complete revolution of the low shaft; then as the low shaft revolves, tappet O^2 commences to raise the treadle bowl R^2 and lever P^2 together with the lifting rod V, which causes the lever X to rise at the point W and turn the oscillating shaft Y clockwise.

The counterpoise weight CW, together with its duplicate at the opposite end, assist in this operation by their own gravity. With the oscillation of the shaft Y the lifting rods V^1 and V^2 elevate the harness lifting board C together with all the harness cords indicated to be lifted by the jacquard cards. Since the lifting rod V^2 is further than V^1 from the oscillating fulcrum Y it causes the harness board C to rise higher than does V^1 thus producing a greater shed in the figuring threads at the back than at the front of the harness. This is what is required in order to produce the straight line of warp threads which form the upper division.

Thus in the jacquard machine from which these diagrams have been made, the distance between the front mail and the fell of the carpet is ten inches; the depth of the shed at this point required to allow the shuttle to pass through it, in front of the reed is five inches and the distance of the back figuring mail from the fell of the carpet is fourteen inches. Then with the knowledge of these factors if x represents the depth of the shed at fourteen inches from the carpet, the value of x can be readily obtained by simple proportion, thus:—

$$\text{As } 10 : 14 :: 5 : x.$$
$$= \frac{5 \times 14}{10} = 7 \text{ inches.}$$

which result exactly coincides with the measurement taken.

Then it evidently follows that the points of application of lifting rods V^1 and V^2 on lever X^1 must be such distances from their common fulcrum on shaft Y as will produce the above result.

Reverting to the elevation of lever X, it in turn lifts rod V^3 and thereby causes lever SL to rise and so turns shaft OS counter-clockwise and moves lever VL together with the sliding bar SB and card cylinder G to the right until the latter is clear of the needles.

Simultaneously with the outward journey of the cylinder, the top catch PC rests immediately over the projecting studs in the cylinder end, one of which strikes against the hook of the catch and thereby turns the card cylinder $\frac{1}{6}$ of a revolution and brings up the next card. When the pressure of the rod V^3 is released the spiral spring referred to above pulls the lever SL rapidly downwards, which through the connections described, causes the card cylinder to strike smartly against the needles.

With the constant revolution of the low shaft the tappet O^2 gradually releases its upward pressure upon the mechanism described above. This then permits the weight of the lingoes to operate upon the board C, which, together with its immediate attachments of rods and levers, fall by their own gravity. The weight CW and its duplicate act in a contrary direction to prevent any rapid or too sudden a fall of the harness and lingoes.

The lower lifting comberboard J, together with the heald H^3 are controlled by a separate arrangement of mechanism. As already shown the whole of the pile threads together with the stuffer threads have to be lifted clear of the shuttle on every second pick *i.e.* the period when the top shed is being formed for the insertion of the wire. The mechanism and method of accomplishing this is illustrated at Fig. 45. Behind the picking tappets on the low shaft a plain tappet PT is secured and adjusted, this operates upon an antifriction roller AF (indicated by the dotted lines) on the tappet lever TL which is centred and free to move about the rocking shaft RS. A lifting rod LR connects the free end of lever TL with the comberboard J and supports the latter as shown. A projecting arm PA supports the stuffer heald shaft H^3 with an adjustable screw AS. The elevation of the comberboard J is accomplished as follows:—As the low shaft revolves, the plain tappet PT elevates the antifriction bowl AF and lever TL with its free end and lifting rod LR, comberboard J, and heald shaft H^3. The reverse motion is accomplished by weight of the lingoes operating on board J together with the gravitation weight of all the parts enumerated; the shape of the tappet regulates the variable velocity of fall owing to the passive resistance which it offers to the various parts in suspension detailed previously.

Action of Cards on Needles or Cross Wires.

Before proceeding to fully detail the action of the jacquard cards on the needles and harness mounting, it will be advisable to set forth in the most complete form, the manner in which the various threads of warp are drawn through the healds and harness, not only in the order of one repeat of draft and warps but also over one complete row of needles.

Split No. 1 and all odd splits or dents. (As Figs. 33 and 40).

1 Thread small chain through mail of heald shaft H^1.
1 ,, ,, ,, ,, ,, ,, H^2
1 ,, stuffer ,, ,, ,, ,, H
1 ,, from frame No. 1 drawn through harness cord No. 1.
1 ,, ,, ,, 2 ,, ,, ,, 3.
1 ,, ,, ,, 3 ,, ,, ,, 5.
1 ,, ,, ,, 4 ,, ,, ,, 7.
1 ,, ,, ,, 5 ,, ,, ,, 9.
1 ,, ,, ,, 6 ,, ,, ,, 11.

Split No. 2 and all even splits.

1 Thread small chain through mail of heald shaft H^1.
1 ,, ,, ,, ,, ,, ,, H^2.
1 ,, stuffer ,, ,, ,, ,, H^3.
1 ,, from frame No. 1 drawn through harness cord No. 2.
1 ,, ,, ,, 2 ,, ,, ,, 4.
1 ,, ,, ,, 3 ,, ,, ,, 6.
1 ,, ,, ,, 4 ,, ,, ,, 8.
1 ,, ,, ,, 5 ,, ,, ,, 10.
1 ,, ,, ,, 6 ,, ,, ,, 12.

These two splits are alternately repeated across the full width of the reed.

The relation between the jacquard needles, the harness and the frames requires to be thoroughly understood before any attempt at 'card stamping' or transferring of the point paper design to the jacquard cards is made. This information is fully supplied at Fig. 40 where the respective needles, harness cords and frames are numbered for easy reference.

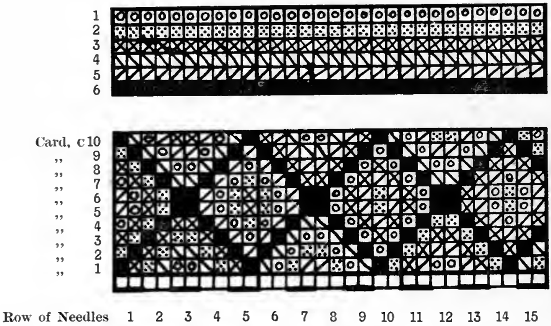
Needle number	1	connects harness cords	1	and	11.
,, ,,	2	,, ,,	2	,,	12.
,, ,,	3	,, ,,	3	,,	11.
,, ,,	4	,, ,,	5	,,	11.
,, ,,	5	,, ,,	7	,,	11.
,, ,,	6	,, ,,	9	,,	11.
,, ,,	7	,, ,,	4	,,	12.
,, ,,	8	,, ,,	6	,,	12.
,, ,,	9	,, ,,	8	,,	12.
,,	10	,, ,,	10	,,	12.

Beginning with the front left hand corner of jacquard and harness and the bottom left hand corner of the design paper, it should be noted that the *odd* numbers of the harness cords B in the board C are passed through the odd rows in board J and odd dents in the reed; these represent the odd ends on the design or point paper. Similarly the even numbers of harness in board C pass through the even rows of board J and even dents in the reed; these represent the even ends on the point paper. The following short table is a summary of the foregoing and should be found useful for reference to all alike.

All Colours in Frames.	Controls all *odd* threads on the design paper and dents in reed.	Controls all *even* threads on design paper and dents in reed.
No. 1.	No. 1 Needle.	No. 2 Needle.
2.	3 ,,	7 ,,
3.	4 ,,	8 ,,
4.	5 ,,	9 ,,
5.	6 ,,	10 ,,
6.	Nos. 1, 3, 4, 5 & 6 Needles	Nos. 2, 7, 8, 9 & 10 Needles

No. 6 frame is always 'on' and consequently the colours in this frame are always lifted unless replaced by any colour from one or other of the first five frames. The harness cords to be lifted on each figuring shed are regulated by perforated cards being

pressed against the needles D. A perforation in the card allows the point of a needle to pass through the card when no action upon the harness cord is effected and no change takes place; but where there is no perforation the card comes against the point of the needle, presses it back and holds the selected harness cord of any one of the five frames together with the corresponding cord of the sixth frame, over the smaller and larger holes respectively of lifting board C so that, as it rises it replaces one of the colours in the sixth frame by one selected from any of the first five frames. Thus any variety of shedding and colourings can be produced on the woven surface by punching the cards to suit it and according to the colours in the frames.



C.—Card.

Fig. 46.

Then whenever a colour from the sixth frame is required, the card must be perforated opposite all the needles in a vertical row representing the first five frames of any given split, but when a colour is required for any of the other five frames, there must be no perforation in the card immediately opposite the needle which connects and controls the harness cord for the given split and frame.

Relation of the perforated cards to the point paper design.

It is necessary at this stage to show how the cards must be perforated so as to operate upon the needles, harness cords and warp threads, and thus produce on the surface of the carpet the same effect of colours as is required by the carpet design. For

the purpose of illustration a small section of a design is supplied at Fig. 46 with a 'gamut' immediately above the design. A gamut is a technical term used to denote the position of all the different colours in the frames containing the figuring threads. Before the design is sent to be 'stamped,' each colour receives a number which coincides with the frame number containing the corresponding colour; these are also respectively indicated by the gamut.

Each vertical row of needles in the needle board and corresponding row of perforations or otherwise across the jacquard card is required to produce the effect indicated by each pair of figuring warp threads on the point paper. For convenience of reference each *pair* of threads is marked off and consecutively numbered in the illustration supplied. In reading off the portion of design given, commencement has been made from the left hand side and with the bottom or first pick. Several firms read from the right hand side, but the merits and demerits of either method is a matter of opinion and custom—the principle is the same. An illustration at Fig. 47 shows how the jacquard cards should be perforated so as to produce the effect of colours which is indicated on the first four picks of sectional design, Fig. 46. The different markings are intended to represent different colours and the frames in which these colours are supposed to be, are shown by the numbers opposite the gamut. The numbers commence at the top, which method coincides with the usual order of numbering the frames of colours. The numbers c1 to 4 on each jacquard card coincide with the corresponding horizontal rows on the point paper.

At this point it should be noted that in a $\frac{3}{4}$, six frame Brussels carpet loom, the jacquard machine has a capacity of 1320 needles controlling 1584 harness cords. The card cylinder is arranged into three equal parts (see Fig. 39) so as to receive three separate cards on each figuring pick, since it would be very inconvenient for a card of single width to operate upon each and all of these needles. Accordingly for the purpose and convenience of subsequent card cutting, each figure design is divided into three parts, each section being first lettered or numbered so as to indicate its true position in the complete design. The lettering commences, as is usual, on the right hand

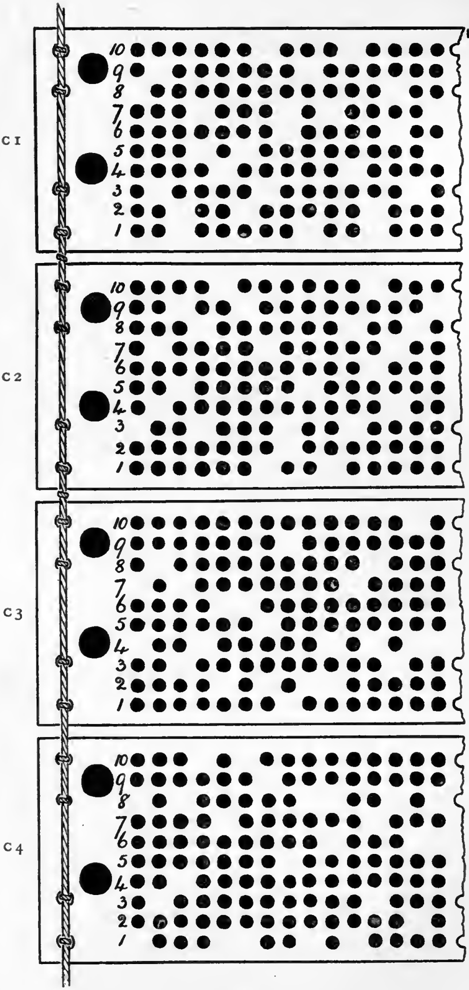


Fig. 47.

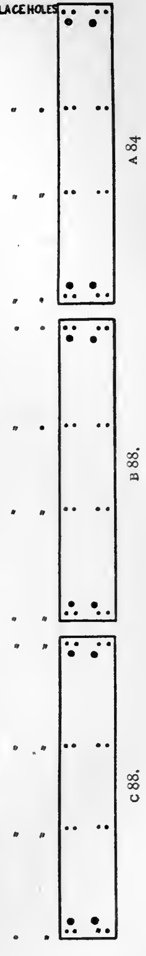


Fig. 48.

side, but this also is a matter which in no way affects the principle of card cutting, for it might with equal convenience commence on the left hand side.

When there are 260 threads of pile in each $\frac{3}{4}$ width of carpet, the design and cards are divided and arranged as indicated at Fig. 48.

Reverting to the determination of the perforated and unperforated portions of the jacquard cards shown at Fig. 47 it will be found best to consider each pair of threads on each wire pick separately, since each represents one row of needles taken in a vertical plane and consequently one row of perforations in the jacquard card. It should be distinctly understood that the first and second threads of each pair respectively indicate the *odd* and *even* threads of the whole design. Then in determining which needle must be selected to bring up the right colour, reference must repeatedly be made to the table on page 97 and Fig. 40 until the student or card stamper can carry the facts contained therein mentally.

Commencing with the first and bottom pick of pile section c Fig. 46, the odd thread of the first pair requires a colour from the *sixth* frame, hence holes are perforated in the card opposite needles 1, 3, 4, 5 and 6 of the first row, or in other words, all the holes for the odd split are perforated; the even thread requires a colour out of the third frame; a reference to the table shows that needle 8 controls the even threads of this frame, therefore the card opposite this needle is not perforated, see card c1. For the second pair of pile threads on this wire pick, the odd thread requires a colour from the second frame and the even thread a colour from the fourth frame. The table shows that needles 3 and 9 respectively control these threads. The card is consequently *not* perforated opposite these two needles of the *second* vertical row. Again, for the third pair of pile threads on this wire pick, both the odd and even threads are required from the first frame. It will be observed from the 'table' that the first two needles control odd and even threads in this frame and the card is therefore not perforated immediately opposite these two needles of the *third* vertical row.

For the fourth pair of pile threads on this wire pick, colours are required out of the fourth and second frames for odd and even threads and since needles 5 and 7 respectively control these threads the card is accordingly *not* perforated opposite these two needles of the *fourth* vertical row. For the fifth pair of pile threads on this same wire, the odd thread requires a colour from the third frame; the table shows that needle 4 controls the odd threads in this frame, hence the card is *not* perforated opposite this needle of the fifth vertical row, but since the even thread requires a colour from the sixth frame, holes are perforated opposite needles 2, 7, 8, 9 and 10, which control the even threads in this row of harness. Each succeeding pair of pile threads on this pick, as well as on the three succeeding picks of pile have been similarly reasoned out. The result is shown on cards c^1, c^2, c^3 and c^4, which the student may with advantage verify for himself.

Picking. The next motion in order is picking and since there is only one shuttle to propel from side to side of the loom, the mechanism which performs this work is necessarily simple. The several parts of this mechanism are illustrated at Figs. 49 and 50, the same letters in each diagram refer to corresponding parts. The former shows a front elevation and the latter a section through the picking shaft L and a full view of shaft D, to be referred to, thereby affording a full view of the picking tappet which consists of a disc A, securely keyed to the picking or low shaft L, with a tappet nose B fastened to disc A; a small cross shaft D placed on the inside of the loom frame and at right angles to the picking shaft L is suitably supported and free to oscillate about its own centre. To this shaft D a short lever C called the picking 'tongue' is keyed fast. A strong spiral spring E, one end of which is fastened to a fixed part of the loom and the other to the shaft D, tends to keep this cross shaft in such a position that lever C is immediately under the tappet nose B and is therefore ready to receive the full blow and force of its stroke when delivered; a bent lever F is *welded* to shaft D; a leather strap G connects F with the picking arm H which arm is free to oscillate upon stud I in casting J. The arm H is supported by means of an iron casting at its base on a stud I which latter

forms part of the shell casting J fixed securely by two set screws to the shaft K commonly called the rocking shaft. Shaft K also supports the sword of the going part though not shown in the illustration. The free end of the picking arm passes through the shuttle box M, the picker is shown at N; corresponding parts are on opposite sides of the loom, except that the tappet nose is diametrically opposed to the position shown at B; Figs. 49, 50.

Motion is imparted as follows:—With the continuous revolution of the shaft L and disc B, the tappet nose B strikes the lever C and causes shaft D to partially revolve on its own axis, producing a

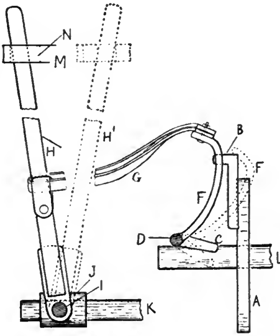


Fig. 49.

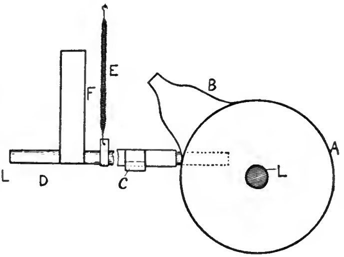


Fig. 50.

rapid forward movement in the bent lever F which through the medium of the connecting strap G also rapidly pulls forward the picking arm H and picker N; the latter presses against the shuttle, forces it out of the box and so propels it through the shed into the corresponding box on the opposite side of the loom.

The Wire Mechanism and Motion.

The insertion of the wire must be timed to enter the figuring shed a little in advance of the shuttle carrying the weft into the ground shed. There are several principles of mechanism and motions in use for this purpose. In these pages it is proposed to describe the

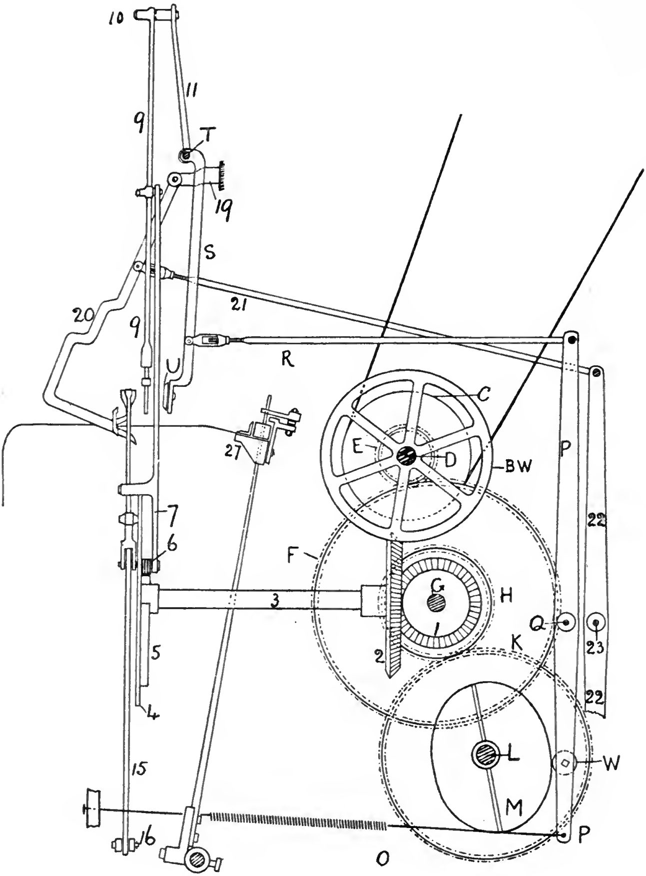

10
11
9
T
19
S
21
20
9
R
U
C
E
D
BW
P
27
7
6
22
F
G
H
3
Q
23
I
K
5
2
22
4
L
W
15
M
P
16
O

Fig. 38.

'Cradle' or 'High wire motion' which is a compound mechanism and possesses the advantage of being applicable to both Brussels and Wilton productions.

Three line diagrams are given for the purpose of illustrating this section of the work. Fig. 38 is an end section of the loom driving and wire motion; Fig. 51 is a front elevation of the wire motion only, while Fig. 52 is a plan of both. The several parts which constitute this mechanism may be defined as follows:

To the low shaft L a tappet M is securely keyed which is kept in rolling contact with an antifriction roller W by means of a strong spring O acting at the lower extremity of lever P; the pivot on which lever P acts is indicated at Q; an adjustable rod R connects lever P with the vertical arm S of the cradle motion. The lever S and its duplicate S^1 are securely fastened to the shaft T which is free to oscillate in suitable bearings attached to the loom framing. The levers S and S^1 in turn support a prepared smooth bar U on which a piece of mechanism marked V and called the 'hopper' can readily slide backwards and forwards. As illustrated at Figs. 38 and 52 a bevel wheel 1 on the crank shaft G gears into a second bevel wheel 2 secured to shaft 3. Shaft 3 being suitably supported carries at its opposite end a smooth circular plate or disc 4; on the inner side of this disc a tappet 5, suitably constructed, operates on an antifriction roller 6 which is supported and free to revolve in the lower arm of the bent lever 7; a couple of strong spiral springs connect lever 7 with the loom fixtures and thereby keep the antifriction bowl 6 in rolling contact with tappet 5; an adjustable rod 8 connects lever 7 with lever 9 as shown in Fig. 51; lever 9 is centred and swings from the stud 10 at the top of lever 11; lever 11 is secured to the shaft T in the position shown. The lower end of lever 9 is in the form of a spindle which passes through and is free to rise or fall in a suitable groove of a small stud in the hopper V, but at the same time it is capable of moving hopper V along the slide U. In front of the disc plate 4 an adjustable arm or plate 12 is secured, a stud 13 projects from it whence an arm 14 connects the lever 15 in the position shown; lever 15, centred at 16, supports and carries at its upper extremity an iron casting called the hook box 17 which is free to slide to and fro on

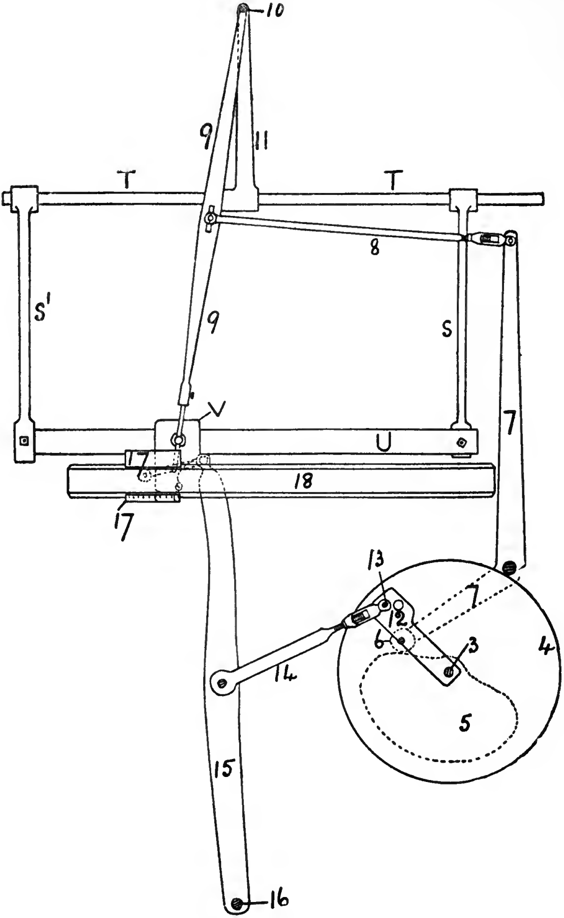


Fig. 51.

the inner side of the straight and smooth bar or slide 18. Suspended from a casting 19 and centred as shown is an irregular shaped lever 20 commonly called the 'swan neck.' Its lower extremity is forked and answers the purpose of a 'wire hook,' which is made to travel backwards and forwards through the medium of a connecting rod 21, operated upon in turn by a simple lever 22, centred at 23. The lever 22 receives its motion from a tappet on the low shaft which is

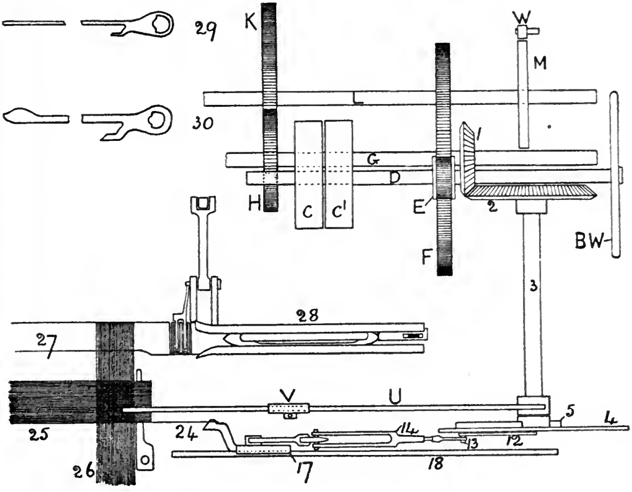


Fig. 52.

on the inside of the loom frame and remote from M. This tappet is kept in rolling contact with an antifriction roller on lever 22 but below its fulcrum 23 and directly opposite the roller W. A reference to the plan supplied at Fig. 52 shows attached to the hook box 17, a hook 24 which is used for pulling the wire out of the fabric and is consequently styled the 'wire guide' since it places the head of the wire into the jaws of the hopper. The correct shape of the separate wires is shown at 29 and 30; the former is for Brussels

and the latter for Wilton carpets. The position of the wires is indicated by the transverse lines 25; the warp threads are represented by the longitudinal lines 26, the race of the going part at 27 and the shuttle and shuttle box at 28.

Relative Motions of the Wire Mechanisms.

The movements which the foregoing wire mechanism has to perform are many and compound.

Observe that the wire has to be inserted once in every two picks for *Brussels*. The motion is eccentric; it commences slowly at first and increases in speed with a constant and uniform acceleration until the centre of its traverse is reached, then it decreases in the same velocity ratio until the wire has been fully placed in the shed.

The hopper commences to move the wire towards the fabric as the sley is travelling towards the harness and by the time the reed has almost reached the cloth on its return journey, the hopper has fully inserted the wire into the pile shed; during this same period the cradle has been moving with the hopper to suit the position required by the wire at various points of its insertion. Immediately the wire is driven home, the hopper and cradle remain at rest, close against the wires for the period of about half a pick in Brussels, but for a much longer period in Wilton; this longer dwell is necessary for the purpose of keeping the wire upon its edge until the weft on the next pick has been inserted and somewhat bound down the pile threads into the body of the cloth. After this the hook box comes along and with its hook pulls out of the carpet the first inserted wire. Meanwhile the hopper is holding the last wire in position in the fabric, after which it follows the hook box with increasing speed; this it not only overtakes but slightly passes—the jaw of the hopper and the wire hook are close to each other at this particular period. The hopper is then reduced in speed so as to permit the hook box and hook with its wire to gradually gain upon it and thereby to draw the wire head into the jaw, prepared to receive it; then hopper, hook box and hook travel together for a time until the hopper reaches its extremity of traverse, but the hook box continues to travel with its constant variation in order to be in position to draw out the next wire on the

pick required. The return journey of the hopper occupies about $\frac{7}{8}$ of a pick but the motion is variably accelerated and retarded. Commencing the return journey slowly at first, it increases in speed for about $\frac{1}{2}$ its traverse, then it decreases in speed for about $\frac{1}{4}$ of the journey and afterwards slowly but variably travels with the hook box nearly to its termination. The hopper travels somewhat further than the hook box so as to allow the wire head to get clear of the hook. There is practically no dwell allowed for the hopper at the end of the slide remote from the cloth.

The variable and alternating movement of the cradle is produced by the tappet M acting upon the anti-friction bowl W, lever P and connecting rod R. Simultaneously the bevel wheel 1 revolving, turns bevel 2, shaft 3, disc 4 with tappet 5 which last when correctly constructed and timed imparts through the bowl 6, lever 7, rod 8 and lever 9, the forward and backward traverse of the hopper V. Also with the revolution of the disc 4, the stud 13, operating through the medium of the connecting rod 14 reciprocates the lever 15 together with the hook box 17 and hook 24; coinciding with these several operations the lever 22 influenced by its respective tappet, already described, alternates through the rod 21, the 'carrier lever' 20 which being correctly set and timed, supports and guides the wire during its periods of insertion or withdrawal.

Beating-up the weft and wires—"Double Beat."

This work is performed by a sley and going part which carries the sley. The motion which is imparted must be of an eccentric character, *i.e.*, a smart stroke must be given to the reed when beating up the weft and wires into the carpet and then a pause to allow the shuttle time enough to pass from side to side of the loom. Owing to the considerable amount of force necessary to drive the weft and wires into position, the going part with the sley strikes against the 'fell of the carpet' twice for each pick of weft. The motion is imparted from the main driving shaft of the loom by the use of cranks which are connected to the sword of the going part. The conversion of the circular motion of the cranks into reciprocating motion of the sley, together with the relative size of the crank and crank arm produce all the eccentricity required. When the crank

arm is relatively shorter than the crank the amount of eccentricity is increased.

An illustration of the essential parts of the 'double beat' mechanism, which performs this work in Brussels and Wilton carpet looms is supplied at Fig. 53.

The position of the crank shaft is indicated at G, the crank at 1; the crank arm 3 is connected with the crank at the position marked 2, about which point they are free to move; a stud 4 joins the crank arm 3 with two connecting arms 5 and 6 and so produces

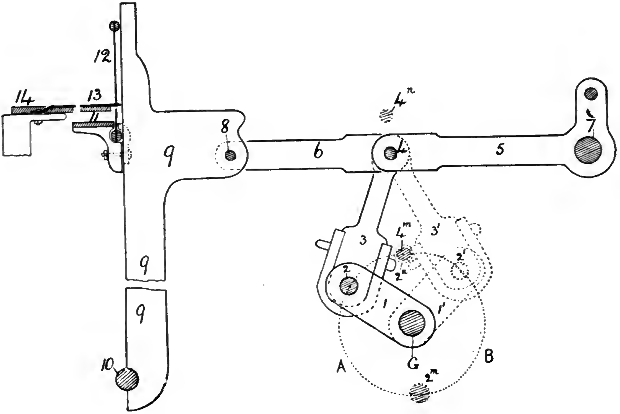


Fig. 53.

at this point a 'knuckle joint;' the connecting arm 5 is secured to a shaft 7' which is free to vibrate, the connecting arm 6 is joined to the projecting part of the sword 9 by a pin 8, the sword 9 is supported and free to reciprocate on a shaft 10 called the 'rocking shaft.' The top part of the sword supports the race 11 on which the shuttle runs and across which the warp lays. The position of the sley as shown at 12 is against the fell of the cloth when the sword is vertical. Represented at 13 is a smooth flat plate which supports the carpet during its passage to the spiked cloth roller; a small iron

finger 14 is securely fastened to the front loom rail, off the end of plate 13 and into this finger the shoulder of the wire (29 or 30 Fig. 52) fits and thereby assists in keeping each wire in an erect position until it is withdrawn. Motion is imparted to the several parts as follows:—with the constant revolution of the crank shaft G in a clockwise direction, the arm I with its centre G and radius G2 traces out a circle which coincides with BA. During the traverse of the centre of point 2^1 to a position indicated at 2 the shuttle leaves the box, enters and passes through the shed and is safely in the box on the opposite side of the loom. When the centre of the crank 2^1 has reached the position 2^m the knuckle joint 4 through the medium 3^1 will have descended to the position 4^m depressing with it the arms 5 and 6; the arm 6 operates through pin 8 and pulls the sword 9 against the harness; by the time the centre 2^m has arrived at the position 2 the knuckle joint 4 is also back to its original position, *i.e.* it has made the arms 5 and 6 *straight* and caused the going part with the sley to beat against the cloth. During the traverse of centre 2 to the position 2^n the knuckle joint 4 gradually rises until it reaches the position 4^n, thus making an angle of the two arms 5 and 6 which shortens the distance between centres 7 and 8 so that the going part 9 recedes somewhat from the cloth, but during the traverse of the crank pin from the position 2^n to its original position 2^1, the knuckle joint 4 resumes the position as shown in the diagram, straightening out the arms 5 and 6, and consequently the sword 9 with the sley 12 strikes against the fell of the carpet for the *second* time on one pick.

'Letting off,' or Warp Controlling Mechanisms.

The small chain warp is controlled by the worm wheel 'let off' motion. See Figs. 54 and 55. The stuffer warp may and sometimes is controlled by a similar arrangement. A simpler and as equally effective a method (as far as the stuffer is concerned) is the twitch rope and simple lever arrangement shown at Fig. 56. The tension on the figuring warp threads has to be regulated separately for each individual thread, since the take-up of each is of a variable quantity. The method adopted is illustrated at Figs. 57, 58, 59 and 60.

Reverting to the small chain 'let off' motion Fig. 54 shows an end elevation and Fig. 55 a plan of same. The corresponding figures in each diagram refer to similar parts.

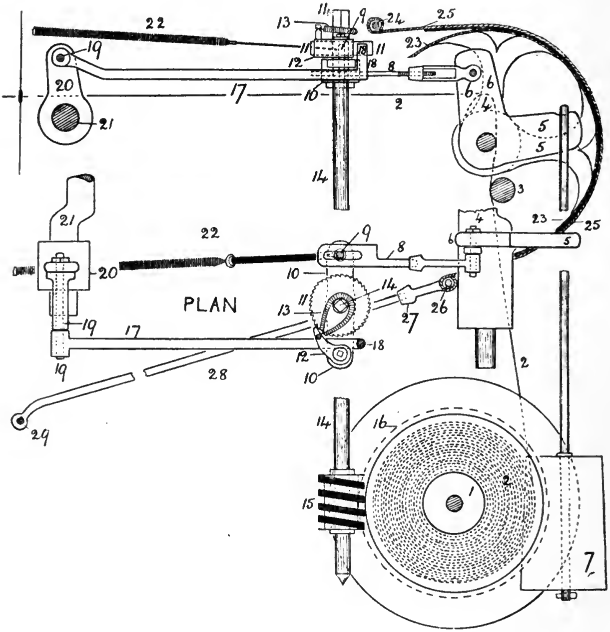


*Fig. 55. Fig. 54.

Tension on the Small Chain.

The warp beam is shown at 1 around which the warp 2 is coiled; warp 2 then passes behind a steel shaft 3 and over the back rest 4, called the 'jumbo,' to the mails as shown. At each end of the rest 4, there are two arms similar to 5 and 6—the former supports the weight 7

as shown, the latter through an adjustable rod 8 called the 'regulator,' regulates the traverse of the upright stud 9 which is fastened to an oscillating lever 10; at the opposite end of this lever is a pawl 12, which is kept in close contact with the ratchet wheel 11 by the spring 13. The lever 10 is free to revolve on shaft 14, but the ratchet wheel 11 is secured to it; the vertical shaft 14 rests in a cup bracket and is suitably supported to the loom framing by an adjustable clasp or collar not shown in the illustration. This arrangement serves the double purpose of a support and a brake to the upright shaft. A worm 15 is securely fastened to shaft 14 near its base; the teeth of this worm gear into the teeth of a worm wheel 16 which is secured to the shaft of the warp beam. A sliding rod 17 with a finger at its free end 18, rests on the top of the loom framing and is free to move laterally in either direction; its opposite end is fastened to a stud 19 projecting from the arm 20 of a supplementary shaft 21 known as the 'rocking shaft;' this is the same shaft as number 7 in Fig. 53; a spiral spring 22 is fastened to the upright stud 9, its opposite end being attached to the loom proper. Upon the remote end of the back rest 4 a semi-pulley 23 is securely fastened; this is called the 'brake pulley;' a stud 24 is fixed in the loom side; to this stud one end of an iron plate 25 called the 'brake' is fastened which passes over the face of the brake pulley 23 to the pin 26; this pin passes through an adjustable swivel coupling 27, into which an iron rod 28 is screwed; the other end of this rod reaches the sword of the going part to which it is screwed by a stud connection 29. The solid black line between the pulley 23 and brake 25 represents a piece of leather which is securely fastened to the brake, the obvious purpose of which is to increase its gripping properties.

The principles underlying the motions of this mechanism may be thus described. The combined action of the brake and the healds constitute the chief factor in regulating the tension on the binding warp or small chain, *e.g.*, when the healds, which always change on the top pick, are passing each other, the tension upon the warp is almost nil and the arm 5 is in its lowest and normal position. Immediately these shafts begin to move, one up and the other down,

they increase the tension upon the binding warp and thereby tend to pull the jumbo forward towards the healds. When the lay is striking the carpet and binding the weft on the *first beat*, the healds should just be crossing each other. This permits the weft to be driven home and binding easily accomplished and also obviates any tendency to drag the figuring threads loosely to the back on the bottom pick, or, to bind them loosely on the wire for the top pick. Then as the lay recedes for the *second beat*, the healds, going in the opposite direction, increase the tension upon the small chain. Meanwhile the small weights suspended on the figuring threads draw them back and so naturally tighten them. The *second beat* simply drives the weft home. The object of the brake is to reduce the use of a dead weight, as at 7, to a minimum, in fact without the brake the carpet could not be satisfactorily woven. With each movement of the 'lay' towards the harness and healds the arm 20 on shaft 21 moves counter-clockwise, which through the stud 19 and rod 17 causes finger 18 to press against the pawl end of lever 10 and make it turn clockwise. The pawl 12 being held in close contact with the teeth of the ratchet wheel 11 and the latter being secured to the vertical shaft 14 both are turned a distance equivalent to a few teeth on the ratchet wheel; with the partial turning of shaft 14 the worm 15 gearing into worm wheel 16 causes the latter along with the warp beam to partially revolve and so unwind or 'let off' the warp. The weight 7 then operating on lever 5 tends to pull the shoulder of rail 4 into its normal position and so keeps the warp at the correct tension. Simultaneously with the forward movement of pawl 12 the upright stud 9 recedes somewhat in the slot of regulator rod 8, but immediately the pressure is released by finger 18, the spring 22 pulls at the stud 9 and turns the lever 10 counter-clockwise, but the slot in rod 8 determines the distance of its movement—the weight 7 acting through arms 5 and 6 also contributes its quota of control.

Tension on the Stuffer Warp.

The respective parts which constitute the mechanism for regulating the stuffer are identical with those of the ordinary twitch rope and brake let off mechanism which is applied to most ordinary looms, the only difference being that the brake lever which is usually

parallel with the warp beam, is in this case, at right angles to it. The end of the warp beam is shown at 23, the flange for supporting the warp at 24; a stout shaft 25 which passes through the centre of the warp beam is supported and free to revolve in the socket of the cast iron support 26, which in turn is secured to the creel framing; a brake pulley 27 is securely fastened to the shaft 25; around this pulley a twitch rope 28 is coiled a few times, one end being secured

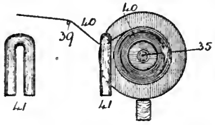


FIG 58

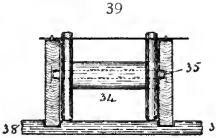


FIG 57

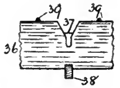


FIG. 60.

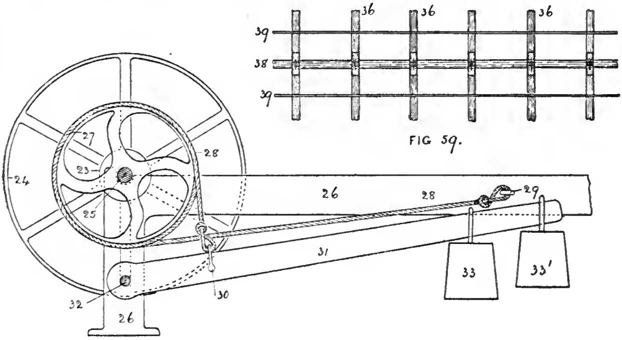


FIG 59.

Fig. 56.

to the frame 26 at the point 29 and the other being fastened at the point 30 to the brake lever 31 and having its centre at the point 32; adjustable weights 33 and 33^1 regulate the tension on the rope 28. This system of warp controlling mechanism is called 'negative.' It cannot be claimed that it satisfies all the requirements of an ideal warp letting-off motion, far from it, yet in the absence of a perfect apparatus it serves its purpose fairly well, being simple in

composition and very superior to some of the ways and means employed by our ancestors. By this system of working, the carpet as it is being taken up, literally drags the warp from off its beam, the rope lever and weights simply act as a resistance to that force. The amount of resistance has therefore to be regulated, so as to equilibrate the pull on the warp by the take up of the carpet.

The difficulties of letting-off would not be so great if the force of resistance required to brake the warp beam was a constant factor, *e.g.*, with a full warp beam the 'moment' of force to turn the beam about its centre is much greater than when the warp beam is nearly empty, consequently there is always a reduced tension taking place in the rope, necessitating repeated re-adjustments of the weights and levers.

Tension on the Figuring Threads.

The take-up of each pile or figuring warp thread is variable, therefore it is necessary to put tension upon each of these warp threads individually. Consequently each pile thread is wound on a separate double headed bobbin. These bobbins are then placed into their respective positions and divisions of a creel made to receive them; each creel, which is called a frame, is capable of holding an equivalent number of bobbins to the number of pile threads on the carpet surface, in one row of pile across its width. A front view of a bobbin in its normal position, together with a section of its frame in elevation is shown at Fig. 57, and an end section at Fig. 58; a plan of a portion of the creel is supplied at Fig. 59 and a side sectional elevation, with the bobbin removed at Fig. 60. The following is a description of its several parts; the letters in each diagram refer to corresponding parts; the bobbin is shown at 34; a wood peg 35 passes through its centre, the ends of which fit into the divisional sides of the creel at the point 37; under each row of bobbins long narrow pieces of wood 38 are fastened across the bottom and at right angles to the divisional sides 36; upon these the bobbins rest; narrow pieces of smooth metal circumscribe the ends of each bobbin and these being in close contact with the wood 38 neutralise any tendency of the bobbins to revolve unduly. The threads, a portion of which is coiled round the bobbin as indicated

at 40, pass over the straight wires 39; a small weight 41 is passed over the thread as shown, the weight of which is sufficient to keep the thread tight but not so heavy as to overcome the resistance of the peripheries of bobbin 34 against the cross wood 38, hence with

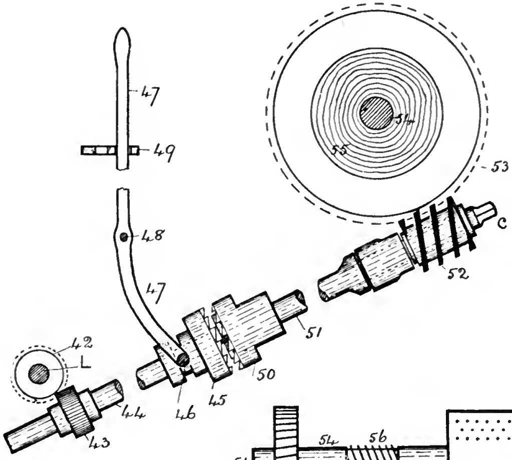


Fig. 61.

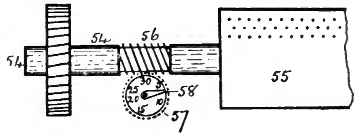


Fig. 62.

each successive take-up of carpet and formation of the pile a sufficient quantity of material is dragged off each respective bobbin.

Positive Take-up Motion.

The chief parts and method of working the mechanism for taking-up the carpet on the 'positive' principle, will be best understood by a reference to two illustrations supplied at Figs. 61 and 62.

The former is an end elevation and the latter a sectional elevation as seen from the front of the loom. Secured to the low shaft L is a single worm 42 which gears into a change worm wheel 43 containing 19 teeth and keyed fast to an inclined shaft 44. A clutch wheel 45 with teeth as shown is placed on this shaft, but is free to move longitudinally along the shaft. A pin 46 passes through the lower part of the hand lever 47 and fits into the recessed portion of clutch 45; the hand lever 47 is centred at 48 but its upper portion fits into recessed parts of a bracket 49. A second wheel is shown at 50 but this is made fast to the shaft 51. Shaft 44 is supported by a suitable casting near the clutch wheel 45; an intermediary socket sleeve is keyed to the end of the shaft 44 beyond the clutch wheel 45. In the socket the upper shaft 51 rests and is free to revolve but a connecting pin fixed in clutch wheel 45, as indicated, rests in a groove of the sleeve socket, and can be pressed into a small hole in clutch wheel 50 and thus made to turn it, together with shaft 51 conjointly with shaft 44 and clutch 45. Towards the upper end of shaft 51 is a double worm 52; this gears into a large worm wheel 53 as shown, usually with 40 teeth and keyed to the shaft 54. A wooden piece beam 55 circumscribes this shaft; a very considerable number of small spikes are let into this wooden beam and their sharp points being outward pierce the back of the carpet and serve the purpose of both holding and carrying it forward with its gradual revolution. The circumference of this beam is 26 inches but it is usual to wrap around it soft pieces of felt or old cloth which of course increase its circumference and take-up of carpet. Into the shaft 54 a single worm 56 is formed which has a small clock worm wheel 57 fitted into its teeth; a pointer 58 indicates the number of yards which have been woven.

Action of the Mechanism.

With the revolution of the low shaft L, the worm 42 gradually turns wheel 43 and with it shaft 44 and clutch wheel 45 the teeth of the latter being set to gear into those of wheel 50; this also turns and causes shaft 51 and worm 52 to revolve together with worm wheel 53, shaft 54 and piece beam 55, the last carrying with it the carpet in regular and positive lengths. Whenever it is

required to let back any carpet the lever handle 47 is moved from its present position to the recess on its left in bracket 49 and so disengages the teeth of clutch wheel 45 from those of wheel 50, the position shown in the illustration. A screw key is then placed on the square end c of shaft 52 which being turned backwards unwinds the required length of carpet. Each tooth in either of wheels 50 or 45 is approximately equivalent to 'one point' or 'wire' in the carpet.

Setting-on, Knocking-off, and Brake Mechanisms.

The arrangement for moving the driving belt from the loose to the fast pulley and vice versa, varies but slightly from the method ordinarily adopted. Whenever it is required to bring the loom to a standstill, it is most important that it should be done with the least possible amount of delay. In a Brussels loom the brake is adapted to fit the inner side of the fast pulley instead of being applied externally to a separate brake pulley as is usual in looms for general weaving. Fig. 63 shows a front elevation of the setting-on handle, belt fork, pulleys and brake attachment. Fig. 64 represents an end view of the same. The markings in each diagram refer to corresponding parts.

'Setting-on' Mechanism.

The setting-on lever is represented at 1. It is securely fastened by two small bolts as shown to a bracket casting 1^1 the latter being keyed fast to a short, hollow and horizontal shaft 2, which is suitably supported by two loom brackets, one being shown at 4. In these two supports the barrel shaft 2 is free to revolve—a second shaft 3 passes through the centre of shaft 2. An iron spring 5 projecting from the loom supports, is constantly pressing against a small antifriction roller 6 in the foot of casting 1^1. This serves to impart spring or elasticity to the setting-on handle 1. To the shaft 2 at the position 7 a vertical lever 8 is made fast, the upper end of which carries a small stud 9 which also passes through the end of a straight rod 10 whose opposite end is supported by a bracket 11 through which it is free to slide. To this slide 10, the belt fork 12 is secured and with it

travels in sympathy, thereby moving the belt from the loose to the fast pulley and vice versa.

The brake attachment.

In the setting-on handle 1 a small casting 13 is secured in the position shown; into either of the small holes 14 and 15 the tip of an adjustable spindle 16 fits; this spindle passes through the free end of the brake

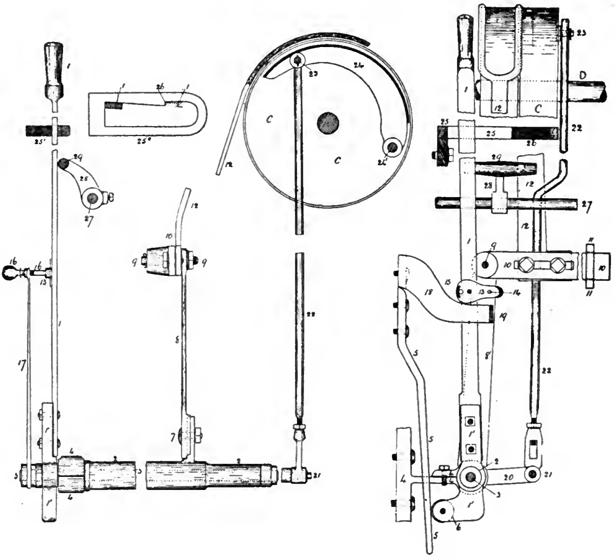


Fig. 64. Fig. 63.

or vertical lever 17 secured at its base to the shaft 3 about which point it is free to move. The tip of spindle 16 when in its normal position is in the small hole 15 under which circumstances it is moved backwards and forwards with the setting-on lever but it can be moved together with brake lever 17 independently of lever 1 until the spindle tip reaches the small hole 14, when, and *only*, when the

loom is stationary. Two stops indicated, one at each end of casting 13 regulate the distance to be moved by lever 17. A bracket 18, secured to the loom uprights, passes immediately behind the brake lever; at the end of the bracket there is a small projection 19 at right angles which determines the limit of the outward movement of lever 17. At the remote end of the shaft 3 a small lever 20, through which passes a stud 21, supports an adjustable lifting and pulling rod 22 the upper end of which is connected by a stud 23 to the free end of an arc lever 24. The opposite end of this arc lever is on a fixed stud 24^1 about whose centre it can partially turn. The face of the arc casting is covered with leather as indicated by the solid black line, and may be brought into frictional contact with the inside of the fast pulley c at will, or automatically, by the application of the mechanism just described. The setting-on lever 1 moves in a fixed bracket near its top which both determines the distance as well as keeps the lever in its correct position whether the loom be in motion or not. A vertical section through its length is shown at 25, another across its width at 25^1 and a plan at 25^{11} and a recessed portion is indicated in the bracket at 26.

Action of the Mechanism.

When the loom is stationary the setting-on lever is in its normal position, as shown at 1, but when motion is required the lever is pressed into the recessed position indicated by the dotted lines at 1. The shoulder in the bracket prevents the lever from springing back into its original and normal position. Then by moving handle lever 1 into the recess 26 it turns shaft 3 clockwise and lever 8 to the right which operates on stud 9 and also moves the slide bar 10 and belt fork 12 to the right taking with it the belt from the loose to the fast pulley c. Simultaneously the lever 20 descends with stud 21 and the rod 22 which latter pulls downwards the stud 23 with the free end of the arc brake 24 thereby releasing all pressure from pulley c. Conversely when the lever 1 is pressed out of the recess 26 it springs back to its original position through the inherent force of the iron spring 5 acting on antifriction bowl 6 thus turning shaft 3, counter-clockwise, and lever 8, stud 9, bar 10 and belt fork 12 all to the left and so moving the belt from the fast to the loose pulley. Acting in consort with these

motions the lever 20 rises with stud 21 and rod 22; the latter acting upon stud 23 lifts the arc brake until it is in frictional contact with the fast pulley c and thereby assists in bringing the loom to a more rapid standstill. Whenever it is required to turn the loom by hand, it is necessary to release the brake from its contact with the pulley; this is accomplished by moving spindle 16 and lever 17 to the right until the tip of 16 is in the position 14; by this means shaft 3 is turned independently of shell 2 clockwise, so that lever 20 descends and the brake 24 is released as just described. If it is desired the brake can readily be replaced. If this is not done, then, when the setting-on lever is moved into the recess 26 it brings forward with it the casting 13. Meanwhile the rod lever 17 remains stationary until the hole 15 in casting 13 reaches it, when the spindle 16 assumes its relative and normal position with lever 1. The numbers 27, 28 and 29 are referred to in detail under the automatic stop motion.

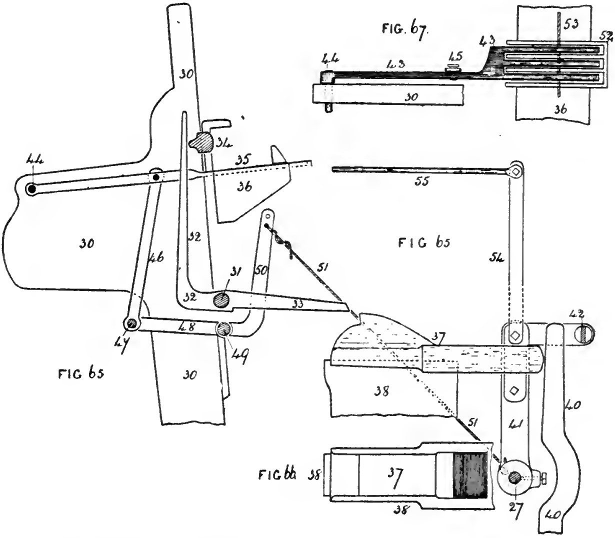
Automatically Stopping the Loom.

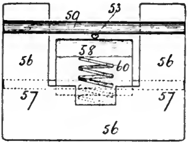
Shuttle fails to reach the box.

If a sufficient force be not applied to the shuttle before it leaves the box from which it has been driven, or from any cause whatever, then in its passage across the loom, it may stop in or near the the centre of the shed with the inevitable result that the going-part, travelling with the reed will carry the shuttle right through the whole of the warp threads, equal in width to the length of the shuttle forming the upper division, unless the loom can be instantly and automatically stopped. In order to prevent such an occurrence an arrangement is made whereby the driving belt can be readily and automatically moved from the fast to the loose pulley and the brake simultaneously applied. Diagrammatic illustrations setting forth the essential features of automatic mechanism, designed and adapted to satisfy the foregoing requirements are supplied and described as follows:—

Fig. 65 represents a vertical section of the 'knocking-off' motion. Fig. 66 a plan of the frog, and Fig. 67 a plan of weft fork and grid. Corresponding numbers in each diagram refer to the same parts. A portion of the sword of the going part is represented

at 30 and the stop rod at 31. The latter is a long rod reaching across both swords to which it is suitably supported and free to oscillate; near to each end a bell crank lever is welded fast; the upright arm or 'swell lever' is represented at 32 and the horizontal





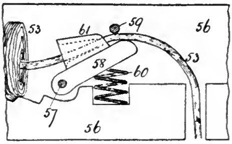


Fig. 66. Fig. 68. Fig. 69.

arm, called the 'wing' of the stop rod at 33. The top part of the swell lever rests constantly against a spring, called the shuttle box 'swell' projecting from the back of the box as shown at 34; the shuttle box is indicated at 35 and the lay of the going part at 36.

The part of mechanism commonly called the frog is represented at 37; it is strongly made and is in the form of a slide, being supported and free to move along the prepared surface of a strong iron casting 38 which is securely bolted to the framework of the loom; on the upper surface of the casting 38 there is a square block or stop, and a hole in the frog about the same width but of longer length fits over this stop; these, in combination determine the limit of the distance to be moved by the frog, see plan Fig. 66. The hammer end of the frog is in constant contact with a strong iron spring lever represented at 40 which thus tends to continually press the frog to the left into its normal position as indicated in the plan. Reverting to Figs. 63 and 64, the rod 27 passes across the front of the loom and is supported by its framework in which it is free to oscillate. A small lever 28 secured to this rod supports a spindle shaft 29 which is in constant contact with the setting-on lever 1. To the same rod 27 a small upright lever 41 (Fig. 65) is secured and rises as shown; near its terminus it projects outwards at right angles to the position indicated at 42, which represents a cross section of a second projection at right angles but passing just in front of the spring lever 40 so that each time the hammer of the frog presses against the spring 40, the latter in turn operates upon projection 42 and through it, lever 41, thereby turning shaft 27 with its parts 28 and 29 just sufficiently to remove the setting-on lever 1 out of the recess 26. At the opposite side of the loom the duplicate of lever 41 is set just immediately in front of the hammer head of the frog, which is thus free to act *directly* upon it.

Action of the Mechanism.

As the shuttle enters the box 35 it presses back the swell 34 which thus acts upon the lever 32 and turns stop rod 31 counter-clockwise and lifts the wing lever 33 clearly above the square end of the stop rod 37; consequently with each forward movement of the going part, lever 33 passes uninterrupted above the frog 37; but whenever the shuttle fails to completely enter the box, the swell 34, allows lever 32 to fall inwards and the rod 31 to slightly revolve so that lever 33 falls into a direct line with the square end of the frog 37. Then as the reed travels towards the 'fell' of the carpet, the wing of the stop

rod strikes smartly against the square end of the frog, causing it to slide somewhat upon the casting 29; the hammer end of the frog then presses against the spring lever 40 which acts upon the projection 42 on lever arm 41 and thereby turns shaft 27 partly clockwise, which through lever 28 and spindle shaft 29 forces the setting-on lever out of the recess 26 and this through the parts already described stops the loom.

The Weft Fork.

In ordinary weaving the weft fork is attached with the object of stopping the loom when the weft breaks or runs off, but in a Brussels loom, this attachment may serve the double purpose of tightening the weft at the edges of the carpet as well as communicating pressure to the setting-on lever and thereby through the connections already explained stops the loom when the weft breaks or runs off. At the present time however the former requirement is more satisfactorily accomplished by a simple weft controlling arrangement applied to the shuttle, see Figs. 68 and 69, and even its application ordinarily as a weft fork is not now generally taken advantage of since there is only one weaver to each loom and he is usually able to watch the weft and thus do without the additional weft fork mechanism and so avoid its attendant difficulties. The principal features of this part of the mechanism are represented in Figs. 65 and 67. The weft fork represented at 43 is supported by a stud 44, about which it is free to turn; suspended from a stud 45, through the shank of the fork is a connecting rod 46; this is fastened by a stud 47 to the horizontal arm 48 of a bell crank lever which is securely fastened to the long rod 49 immediately under, parallel and similarly supported as rod 31.

To the upright arm 50 of the bell crank lever, a cord or string 51 connects it to the rod 27; the fork grid is shown at 52 and the weft at 53; an extension of the arm 41 indicated at 54 supports and is free to move a straight rod 55, the end of which just passes under the tips of the weft fork when in perfect working order, but if the fork is permitted to fall low enough, its tips come in contact with the end of the straight rod 55 and press it outwards producing the result hereafter described.

This arrangement also enables the weaver to stop the loom when he is at the opposite side to where the setting-on lever is placed, should there be any immediate cause for doing so.

Action of Weft Fork.

As the going part moves backwards towards the healds the string 51 pulls forward the lever arm 50 and elevates the arm 48 which through rod 46 acting on the stud 45, lifts the weft fork about the stud 44, so that the fork or free end is lifted sufficiently high as to permit the shuttle with the weft to pass under it. Then as the reed travels forward towards the carpet, the fork falls upon the weft as it lies across the grate and this tightens or takes up any slack, thereby assisting to make a neat and perfect edge of carpet, but if the weft 53 breaks or runs off, the tips of the fork fall lower and strike against the end of the straight rod 55 which through its connection with 'knocking off' rod 27, moves the lever arm 28 and spindle shaft 29 against the setting on lever 1, presses it out of recess 26 and through mechanism already detailed, stops the loom.

Tightening the Weft by a Contrivance in the Shuttle.

The process of tightening the weft is now more generally accomplished by means of a simple arrangement in the shuttle called the '*Tension* weft trap.' Fig. 68 shows a cross section which contains this arrangement, thus affording a front view and Fig. 69 shows a section longitudinally through the shuttle with a side view of the arrangement. The framework of the shuttle is represented at 56; a pin 57 passes through its sides and a brass swivel 58 is kept in close contact with the ordinary pin 59 by means of a swivel spring 60. The weft 53 passes from the weft cop as shown, through an eye in the brass projection 61 between the swivel 58 and pin 59 to the usual eye in the shuttle. The combined action of the spring and swivel against the weft and pin prevent any rapid withdrawal of the weft from the cop and consequently contributes to the production of a perfect edge.

CHAPTER IV.

Wilton Carpets.

Comparative Description.

A Wilton carpet primarily belongs to the cut or velvet pile class of fabrics. In many respects it is similar to a Brussels. It is woven in the *same* loom and frequently the same particulars of warp and weft are employed. It is however advisable and customary to use better qualities of figuring and small chain warps, though in other respects they bear a corresponding relation to the materials represented at Fig. 29.

The wire used for Wilton (see No. 30, Fig. 52) is usually deeper and therefore produces a loftier pile than Brussels; it con-

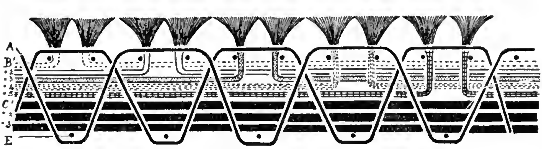


Fig. 70.

tains a knife edge at the end of the wire which passes through the shed. When this wire is drawn out it cuts the loops and consequently imparts the velvet appearance, which to a *casual* observer constitutes its chief difference when compared with Brussels. But inasmuch as the loops are *cut*, they involve a difference in the method of binding in order to prevent the small tufts from being easily pulled out or detached by wear and tear, for though the Brussels system is ideal where the pile remains in loop form, it is nevertheless unsatisfactory when cut, since it leaves the tufts insufficiently bound. The structure of a three frame Wilton carpet is illustrated at Fig. 70 which represents a cross section through the weft. The differences in structure will be evident when it is compared with the illustration supplied at Fig. 30, page 77. The letters in each diagram refer to

corresponding threads; A B C D represent the small chain, figuring warps, stuffer chain and filling respectively. It will be manifest that there are *three* shots of weft in Wilton to each wire and tuft, as compared with *two* in Brussels.

In the Wilton structure the first and third shots of weft are over each row of tufts, so that each tuft is virtually bound twice, whereas if each row of loops in Brussels were cut there would only be one shot of weft laid across each row of pile. Hence the *three shot* method of binding is the more satisfactory, in fact it is about the best system of binding adopted in any of the *velvet* class of pile carpets, which accounts in some measure for its comparative durability.

Designs and colourings which are made for Brussels are also suitable for Wilton except that a design prepared especially for the former will usually be somewhat foreshortened if used for the latter make, since a good velvet requires more wires per inch. All the better class of velvets have ten and frequently eleven wires per inch. The colours are also much softer in tone through the cutting of the pile threads—a fact which it is important to remember.

Modification of Brussels Mechanism.

Though woven in a Brussels loom, there are several modifications necessary, the principal of which arises from the fact that three shots of weft are required to be put into the carpet for the insertion of each wire.

The parts of mechanism which involve a change are:—

1. Shedding for the ground warps.—Small chain.
2. ,, ,, ,, figuring ,,
3. Picking.
4. Insertion, withdrawal and timing of the wires.
5. Take-up.

Small Chain Shedding Mechanism.

As shown in Fig. 70 there are three picks of weft in each shed of the base structure, which involve each heald shaft alternately rising and falling on every third pick. Reverting to Figs. 43 and 44 pages 89 and 90 illustrations of the tappet mechanism which

control the healds in *Brussels* weaving—the following changes are necessary here:—The small pinion wheel M together with the tappet wheel N which contain 30 and 130 teeth are replaced by two wheels having 20 and 120 teeth respectively; the latter gear causes the tappet wheel to make *one* complete revolution while the crank shaft is making *six*. The tappets O and O^1 are also replaced by two others which are so constructed, timed and set as to cause the heald shaft H^1 to rise and remain up for three picks; during the same period heald H^2 falls and remains down for three picks, but on the subsequent three picks this order is reversed, at the end of which period a complete circle has been described by the tappets.

The following essential particulars, for the purpose of construction are also useful in indicating the time allowed for change and period during which the heald must remain stationary, and also the stroke of tappet to produce the required depth of shed.

1. Weave 3 up and 3 down.
2. Diameter of bottom run—(inner-projection O) where heald is down, 9 inches.
3. Stroke of tappet $3\frac{3}{8}$ inches.
4. Dwell = $\frac{1}{2}$ revolution of crank shaft plus 2 picks = $2\frac{1}{2}$ picks, leaving $\frac{1}{2}$ pick for change.
5. Diameter of antifriction bowl $1\frac{3}{4}$ inches.
6. Radius of lifting cover—(outer-projection O^1) $7\frac{1}{2}$ to $9\frac{1}{2}$ inches
7. Length of treadle lever P 32 inches.
8. Distance of centre of treadle bowl R $17\frac{1}{2}$ inches from fulcrum.
9. The arms of the jack levers S^1 and T^1 are 15 inches on the tappet side and 20 inches on the heald side of the fulcrum.
10. The distance of the front heald from the carpet is $16\frac{1}{2}$ inches.
11. The stroke of the going part is $6\frac{1}{2}$ inches.
12. The depth and width of the shuttle are $1\frac{1}{2}$ and 2 inches respectively.

Figuring Shed Mechanism.

Since there are three shots of filling to each wire, it is only necessary to form the figuring shed on every third pick. On this account the bottom shaft L is designed to make one complete revolution to every three of the crank shaft G; this is attained by substituting the

two wheels H and K which contain 48 and 96 teeth, for two similar wheels having 36 and 108 teeth respectively. The tappet O^2 (Fig. 45) which operates, through mechanism already described, on the harness lifting board and card cylinder, is replaced by a tappet O^3 secured to the shaft L as at Fig 71.

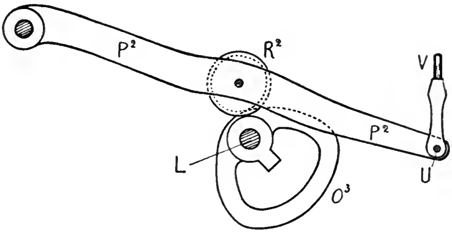


Fig. 71.

The details of the tappet for the purpose of construction are approximately as follows:—

1. Plan 1 up and 2 down.
2. Radius of tappet in contact with the antifriction bowl R^2 when the harness is at the bottom equals 2 inches.
3. Dwell of harness at the top equals $\frac{3}{4}$ of a revolution of crank shaft.
4. Time allowed for lifting the harness equals $\frac{1}{4}$ of a revolution of crank shaft.

Wire Motion Mechanism.

For reasons previously stated the wire mechanism must be designed so as to complete its circle of movements during a period of three picks. In order to thoroughly understand this part of the work it will be necessary to refer to Figs. 38, 51 and 52. Tappet M on shaft L in Fig. 38 is replaced by a tappet constructed after the pattern M^2 Fig. 72 and imparts the required reciprocating movement to the cradle lever S through mechanism described in connection with the above figures.

The varieties of the movement cannot be better set forth than by a consideration of the following constructional details, which are necessarily subject to variation according to local conditions.

a. Time occupied in one revolution of tappet equals three picks.

b. Beginning with crank at its front centre and lathe or cradle bar U with hopper against the fell of the carpet then:—

1. Dwell of cradle bar U against the fell of the carpet	equals	$1\frac{1}{2}$ picks.
2. Travelling forward towards the hook box and wire	,,	$\frac{1}{4}$ pick.
3. Dwell against hook wire at extremity of stroke	,,	$\frac{5}{8}$,,
4. Cradle bar returning and hopper carrying wire to shed	,,	$\frac{1}{4}$,,
5. Cradle bar returning and hopper carrying wire into shed	,,	$\frac{1}{4}$,,
6. Cradle travelling towards fell of carpet	,,	$\frac{1}{8}$,,
Total time equals		3 picks.

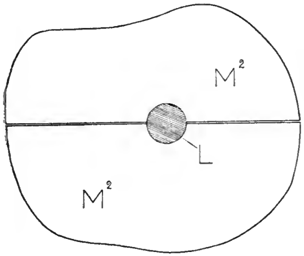


Fig. 72.

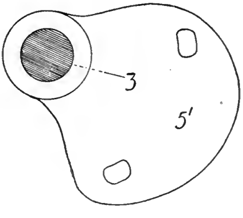


Fig. 73.

The swan neck lever 20 operated by its own respective tappet must of necessity act in consort with the changed conditions of the cradle bar U.

The bevel wheels 1 and 2 on shaft G and 3 containing 27 and 54 teeth respectively are likewise substituted by two similar bevel wheels but containing 20 and 60 teeth respectively, which being in the ratio of 1 to 3 cause shaft 3 to make one revolution, while the crank shaft is making three. Then through connections previously described, the lever 15 reciprocates the hook box once in every three picks; the tappet behind the disc plate 4, is also replaced by another corresponding to that shown at Fig. 73, designed and constructed to the following approximate details:—

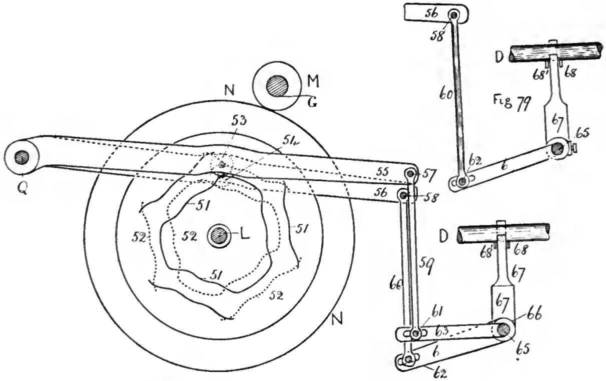


Fig 74

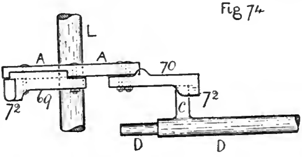


Fig 77

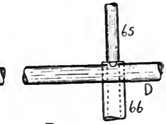
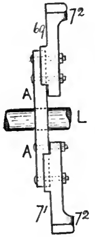


Fig 75



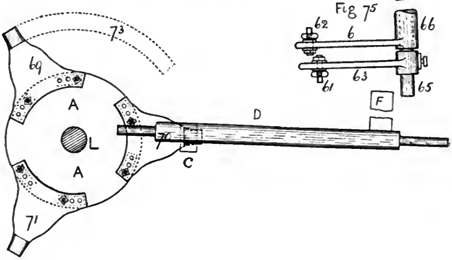


Fig. 78.

Fig. 76.

a. Time—one revolution equals three picks.

1. Inserting wire, motion uniform	time	$\frac{5}{8}$ pick.
2. Dwell of hopper against fell of carpet and the wires	,,	$1\frac{1}{2}$ picks.
3. Withdrawal of wire, motion variable	,,	$\frac{7}{8}$ pick.
	Total	3 picks.

Picking Mechanism.

Since the low shaft L, Figs. 49 and 50, containing the picking tappets, is now making one revolution to every three of the crank shaft G and picks inserted into the carpet, it necessitates a modification of the picking tappet in order to propel the shuttle from one side to the other of the loom. The modified arrangement showing the essential features of the mechanism designed to solve this problem is illustrated from Figs. 74 to 78 inclusive.

Fig. 74 shows a sectional elevation of the tappets, treadles, rods and levers used to produce the required lateral movement in shaft D and tongue C. Fig. 75 shows a plan of the right hand portion of same. Fig. 76 is a vertical section through the picking shaft L thus permitting a perspective view of one complete picking tappet A together with the supplementary shaft D and picking tongue C. Fig. 77 is a plan of same and Fig. 78 is a front view of shaft L and picking tappet A.

To each tappet disc A, three adjustable tappet hammers or noses equidistant, are secured. Consequently each picking tappet is free to strike the picking lever or tongue C, simultaneously on *every* pick, but the picking tongues C, at either side of the loom, are alternately and automatically moved laterally out of striking reach of the tappet nose. Consequently though both noses strike together, only one produces a positive result.

On the inside of each striking hammer 69, 70 and 71 there is a slight projection, 72. This is the part of the tappet nose which strikes against the tongue C and produces the pick. Ordinarily the picking tongues at either side of the loom are adjusted so that as one is in full striking radius of the tappet nose 72 the other is outside and clear of the striking part. In the position of the mechanism as shown at Fig. 74 the tongue C on the left hand side is immediately in striking range of the tappet nose while its duplicate

on the right hand side is clear. These positions are reversed on each succeeding pick. Secured to the same tappet boss and tappet wheel N heretofore described, are two 'positive' Woodcroft tappets marked 51 and 52, the last named being immediately behind the first as indicated by the dotted lines. Each of these is kept in rolling contact with, and exerts a reciprocating influence upon, the two respective antifriction rollers 53 and 54 and through them, the corresponding treadle levers 55 and 56, centred at their common fulcrum Q. Towards the free ends of these levers two studs 57 and 58 in order join them to the connecting rods. 59 and 60. These in turn are similarly attached by means of studs 61 and 62 to the two arms 63 and 6. The arm 63 is centred and made secure to the shaft 65; this shaft is the full width of the loom to which it is supported. The arm 6 is cast with the barrel shaft 66 which is on and free to oscillate about the shaft 65; it is of such a length as to reach immediately under the cross shaft D on the left hand side of the loom and to this terminal end a short vertical lever 67 is bolted, the upper end of which is forked and partly circumscribes the shaft D. Two strong pins 68 and 68^1 project from the shaft D in the manner shown, so that if any oscillation takes place in the lever 67 it is free to operate upon the pins and thus cause a lateral movement in the shaft D together with that of the picking tongue C until it is clear of the circle described by the picking nose. A duplicate lever to 67 is secured near the opposite end of shaft 65 and is correspondingly free to act in a similar way upon a duplicate of shaft D and picking tongue C, but on the opposite pick. Each of the foregoing tappets is designed and constructed to the following particulars :—

Plan—*one* up and *one* down; diameter of thinnest part of tappet $4\frac{1}{2}$ inches; stroke of tappet 1 inch; dwell $\frac{7}{8}$ pick; diameter of antifriction bowl $1\frac{1}{2}$ inches; the lengths of the several levers and points of application 55 to 68 are adjusted to produce a lateral movement of $1\frac{1}{2}$ inches in shaft D. Since the tappet boss makes only one revolution to every six picks of filling inserted, each tappet is constructed with three rises and three depressions to one round. Both tappets are set diametrically opposite, adjusted and fixed to

the boss of tappet wheel N in such a position that when one is lifting, the other is depressing its respective treadle lever.

Action of the Mechanism.

Then the tappets, which are continously revolving with the tappet wheel N, operate through the bowls, treadle levers and connecting rods and generate motion in the levers 63 and 6, shaft 65 and barrel 66. When tappet 52, through its connections, elevates lever 6 the latter will turn barrel 66 with its lever 67 on the left hand side of the loom in a direction clockwise; the upper part or forked end of lever 67 then acts upon the strong pin 68 and thus moves the cross shaft D with its lever C from its present position a sufficient distance to the right, until lever C is outside the circle described by the tappet hammer or nose 72. Simultaneously the cover of tappet 51 depresses through its intermediate parts the lever 63, which in turn partly revolves shaft 65 with the duplicate of lever 67 on the right hand side, counterclockwise; the latter acting through parts understood, moves shaft D inwards to the left until the tongue C is directly under the picking projection 72. Consequently the picking mechanism being engaged on the right hand side of the loom, the shuttle is accordingly propelled from that side.

Then on the succeeding pick, the tappets 51 and 52 acting through their intermediate parts produce a lateral movement in shaft D to the left and in its duplicate to the right; the stroke of the tappet therefore, this time misses on the right hand side of the loom but picks from the left. The remainder of the mechanism for propelling the shuttle is identical with that of Brussels.

Lateral movement of the Picking tongue, Alternative Method.

It should be noted that the projection 72 can only strike the tongue lever C when it is within the limits of the circular band shown at 73. This makes it possible to adjust the shaft D so that the picking tongue C on the right hand side of the loom is just within striking range of the outer half of projection 72 and circular band 73; but on the left hand side of the loom it is within striking range of only the inner half of the projection as at Fig. 77. When the tongue C, on the right hand side of

the loom is within striking range of the tappet, its duplicate on the left, is inside the circle 73, clear of the striking force; but when the tongue on the left hand side is within striking range of the picking force, its duplicate on the right hand side is outside the striking circle 73. This result is obtained by a simple lateral movement of the shaft D, inwards and outwards alternately.

This is accomplished by removing tappet 51, antifriction bowl 53, treadle lever 55 together with parts 57, 59, 61, 63 and barrel shaft 66, and then connecting lever 6 to shaft 65. The plain tappet 56 with its rise and fall is thus free to turn shaft 65 alternately to the right and left and through its connections correspondingly move the shaft D and tongue C. This arrangement is illustrated at Fig. 79. Then, when the tappet 52 elevates the treadle lever 56, it in turn through intermediate connections causes shaft 65 with its upright arm 67 and its duplicate on the opposite side of the loom to move outwards to the right. The latter moves the tongue C, on the right hand side, just outside and clear of the striking circle 73 of the picking nose 72 while the tongue on the left hand side is brought into range of the striking circle 73. Consequently the shuttle is picked from the left hand side of the loom, but when the treadle 56 is depressed by the cover ring of the tappet, the direction of the movement of the foregoing parts is directly contrary, so that the tongue C on the left hand side of the loom is pressed inside the striking circle 73—clear of the tappet nose projection 72—whereas its duplicate tongue, on the right hand side, is brought into striking radius, with the result that the shuttle is, this time, driven out of the right hand box, and so the operation is repeated.

The subsequent principles of beating up, letting-off and taking-up are in all other practical details coincident with those of Brussels except in the case of taking-up where there are three shots to one wire; the worm wheel 43 Fig. 61, which contains 19 teeth for Brussels is substituted in Wilton by a worm wheel containing 13 teeth which numbers are approximately and inversely proportionate to two shots of the former as compared with three of the latter.

CHAPTER V.

Factors common to Brussels and Wilton Carpets.

Designing. The designs for these carpets are planned, drawn and coloured on specially ruled paper so as to facilitate the transference of the design to the jacquard cards, by the process of punching or stamping holes in them. Each hole or equivalent space in the card represents one of the small squares on the point paper and also one loop or point in the carpet and each horizontal row of small squares represents one complete jacquard card. A jacquard card correctly punched controls the needles and harness cords in the jacquard machine which through mechanism explained causes the correct colour of warp thread to be lifted. The designs may be made to the actual size or some convenient scale. All things considered it is better to make the pattern full size and especially is this the case with beginners.

The size of paper on which the pattern is to be drawn is determined by the fineness of the pitch of the loops or tufts in the carpet. If 260, 256, 234 or 216 loops per $\frac{3}{4}$ yard width of carpet be required, and assuming that the number of wires are relatively or approximately the same as the loops in the width, then the ruled papers would contain respectively 10×10, 9×9, and 8×8 divisions in each of the larger squares; the length of the point paper depends exclusively on the length of the design; if the design be short it involves a too frequent repetition of prominent parts. In a $\frac{3}{4}$ yard width the pattern is usually about 36 inches long. Frequently there are fewer wires per inch than loops in the width, thus 10×9, 9×8, and 8×7 are of common practice. In almost all cases the number of wires in Wilton as compared with Brussels varies from 1 to $1\frac{1}{2}$ wires more per inch, necessitating the use of paper containing 10×11, 9×10, and 8×9 squares per inch assuming that the design is primarily made for the velvet structure; otherwise if the design be first prepared on Brussels

paper and subsequently used for Wilton it will when woven be shorter in proportion to the above relative figures.

Colouring. Colour is the first thing that strikes the eye in a decorative carpet; the best design may be spoiled and the poorest redeemed by colour. In Brussels and Wilton the schemes of colouring may and often are improved by changes in the loom, an advantage which does not apply to the manufacture of any other class of carpet. The colours in each section of the design are quite distinct from their contiguous colours, hence gradation is somewhat restricted and as a consequence form is more frequently and effectively represented by mass than by outline.

The number of frames available determines the number of *complete* colours which can be used without restriction in any part of the design, but by a judicious planning or planting, several additional colours may with advantage be introduced and these then replace part of the colours in some given frame. The chief factor, however, to keep in mind is that with six frames in use, it is possible to have *six* colours and *six only* in any given row of loops running with the length of the carpet or the design, while across the width, every individual figuring thread and loop may be of a different colour. In both Brussels and Wilton structures it is possible with comparatively little difficulty to change or transpose any two frames of colour in the same pattern.

On account of this possibility and from a commercial point of view it is advisable to so dispose the colours as to admit of the greatest possible number of effects by transposition. In ordinary commercial life the firm having the greatest selection can usually obtain a higher price for their goods besides being in a position to secure a more satisfactory and permanent trade; then, as a natural sequence, it follows that if several carpets can be woven from the same set of cards in different colourings, the field of choice is increased at the minimum amount of cost. This principle is often worked to considerable advantage; the designs are produced with the view of being able to use two, three or more sets of colours which look well on the same ground or a set of colours which agreeably assorts with different ground colours. Sometimes a

divisional colour is used as an outline with this object in view, but this introduces features and restrictions which produce an objectionable stiffness.

As a rule the ground colour should be used only for the ground and not frequently introduced into the figure; then, when the ground is changed it will obviate any spotting of the figure with unsuitable and unfriendly colour tints, which though they agree with the original scheme do not necessarily accord satisfactorily with the changed conditions. There are however times when the ground colour may with some advantage be introduced into the figure, since it adds variety and sometimes freshness to the pattern.

When however the ornament is on a ground of contrasting colour it *may* have an *outline* of a brighter tone than the figure; if the figure is on an orange, bronze or light coloured ground, it may have an outline of a darker tone than the ornament. In the lighter portions and upper reaches of the ornament, the brighter colours and the primaries should be used, while the secondaries, tertiaries and darker tones are best adapted to the lower reaches of any portion of the ornament.

Planting. The process and principle of planting permits the substitution of colours in *stripe* form only; the employment of a number of colours simply with the object of producing variety may possibly and often does defeat its own object.

By the process of planting a 'four frame' can be made to look like a five or six frame, a 'five frame' like a six or seven and a 'six frame' like a seven or eight and even more, if the colours are judiciously planted. It is this fact which makes it difficult for a non-technical mind to determine the number of frames which have been used and consequently to correctly estimate the quality of the carpet as far as this factor influences it. The chief objection to planting is the tendency to stripe.

The principle of planting will be best understood by a consideration of the portion of planted design at Fig. 80. It represents a portion of the centre or filling of a six frame Wilton stair; the fourth frame only, in this section, is planted. In the full width of the stair, this frame contains four different colours or plants, the

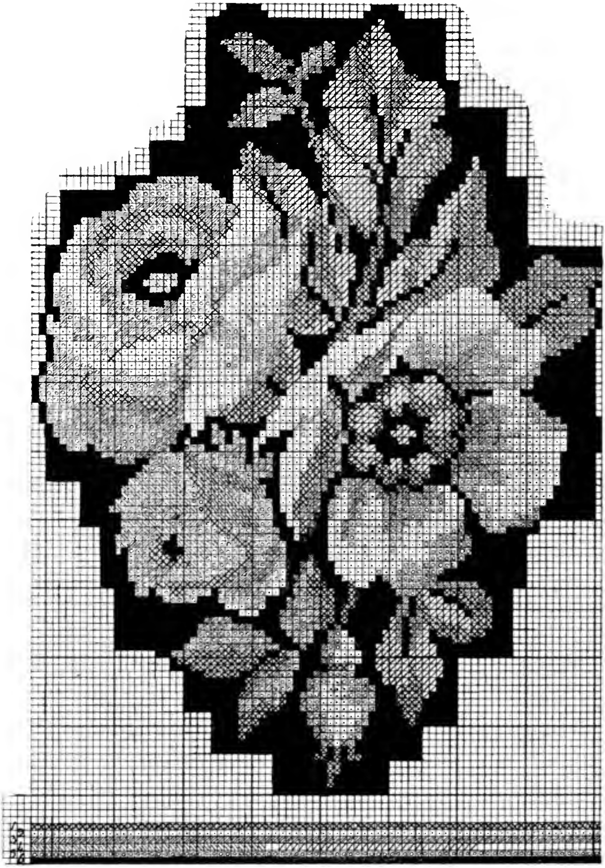
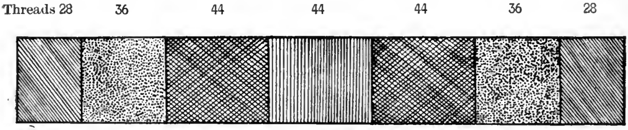


Fig. 80.

remaining five frames are solid colours throughout. The substitution of one colour in part of the frame only should serve as an introduction to a clearer conception of the principle of planting, since, when the idea is first realised, the fullest scope of its possibilities is only a matter of application, time and exercise. In this example the portion of ornament (somewhat realistically rendered) has been sketched full size on 10 × 10 paper but reduced by photography to half-scale so as to exhibit as much as possible of the ornament. The following are the colours actually used. Frame 1, smoke; 2, cream; 3, olive; 4, salmon and lavender; 5, drab and 6, cardinal. The several colours in the design are indicated by the different kinds of markings and the frames in which these respective colours are placed are shown by the gamut below, the upper line of which represents the first frame and the numbers beneath indicate the position of the remaining frames in arithmetical order. It will be evident that the *planted* colours are salmon and lavender as represented in the fourth frame. The spools are arranged in the frames in the order as indicated by the gamut beginning at the right hand side. Generally one frame is set apart exclusively for planting purposes, but occasionally plant colours are introduced into several of the frames; as a rule, the plants ought to be in the second, third or fourth frames so as to be within easy reach of the weaver, since they require most frequent attention. See also plate I, Fig. 26.

The plant of a design is always indicated in the gamut, consequently it is only necessary to denote the colours which have to be planted, on a narrow strip of paper the full width of the design. Then, after having decided on the ground and the other full frames of colour (which impose no limitation because any of them can be brought to the surface in any part of the design) the planted colours can only be raised for figuring in a straight line longitudinally according to the width of the coloured band or number of coloured threads which they each represent. Occasionally the planting colours are distributed over the repeat area first. The centre of each mass or strip of colour should be constant whereas the colours, as they approach nearer to the edge of each division, might graduate in tone towards their adjacent strips of colour. Thus in the narrow strip

of four colours representing light green, yellow, orange and red as indicated at Fig. 81 the light green might incline to yellow on the yellow side and the yellow towards green on the green side, but approach nearer to orange in the division nearest that colour; similarly orange might become yellower on the left but redder



Fig, 81.

on the right hand side and so the red might be nearer in tone to orange on that side but somewhat colder and nearer the green, where this colour is adjacent to it. The obvious result of this method is to reduce to a minimum any tendency to a striped appearance.

The remaining five frames are each filled with their own respective colours.

Moresque effects and planting for same.

Moresque effects are used in Brussels and Wilton structures either as whole frames or plants. They are produced by the introduction of fancy twist threads *i.e.* yarns made up of two or more differently coloured threads twisted together; these when used in place of the ordinary solid coloured thread produce the mottled or above-named effect. Though this method considerably improves the general appearance it also materially increases the expense of production. With the object of saving the cost of twisting as well as the expensive figuring material two or three whole frames may be filled with solid colours of a yarn each equal in count and weight to one half that of the ordinary three ply yarn which is used and the remaining three frames filled with solid colours of the usual counts of figuring material, *e.g.*

Frame 1.	All 3/2/18	Worsted—	Navy Blue.
,, 2.	,,	,,	Bronze.
,, 3.	1/2/12	,,	Cream.
,, 4.	,,	,,	Red.
,, 5.	,,	,,	Light Blue.
,, 6.	3/2/18	,,	Olive.

The moresque effect is now obtained by lifting two of the 1/2/12 worsted in any given split, over the same wire, *e.g.* one thread cream out of frame 3 and one thread red out of frame 4; similarly cream and light blue or red and light blue in their same respective splits may be correspondingly lifted. By blending two singles as they are called, of totally different shades in the manner described, a saving is effected in the figuring warp—the most costly material, while at the same time the carpet possesses all the characteristics of a six frame structure, though the weight of the figuring warp in this example is actually only equal to $4\frac{1}{2}$ frames. The extra weight and balance of carpet can easily be made up by the addition of a dead or stuffer warp. Care must be taken, however, to make the width of the plant in each and all the frames agree. The following examples will serve to make this section of the work perfectly clear.

Example I.

Frame 1	All 3/2/18 Worsted—Shade A				
,, 2	,, ,, ,, ,, B				
,, 3	3/2/18 C	1/2/12 H	1/2/12 K	1/2/12 H	3/2/18 C
,, 4	,, D	,, I	,, L	,, I	,, D
,, 5	,, E	,, J	,, M	,, J	,, E
,, 6	All 3/2/18 Worsted—Shade F				

In this example the following combinations are possible and will be readily perceived. HI, HJ, IJ on the right and left divisions and in the centre KL, KM, LM, thus producing six effects of twist in addition to the six ordinary colours, A B C D E F.

Example II.

Frame 1 A	All Solid Colour			A		A
,, 2 B	Single M	B	Single W	B	Single M	B
,, 3 C	,, N	C	,, X	C	,, N	C
,, 4 D	,, O	D	,, Y	D	,, O	D
,, 5 E	,, P	E	,, Z	E	,, P	E
,, 6 F	All Solid Colour			F		F

Here it will be observed that the solid colours are A B C D E and F for frames 1 2 3 4 5 and 6 respectively; the planted single colours are M N O P and W X Y Z for the frames 2 3 4 and 5 respectively; then, it is possible to blend as follows:—MN, MO, MP, NO, NP and OP making six effects in this section and similarly six other effects in section WXYZ, which in addition to the six solid colours makes eighteen colours in all—the whole possessing the characteristics of a planted six frame carpet.

In this class of pattern, special check papers are required for the purposes of colouring. The ordinary ruled paper of 10 × 10 per

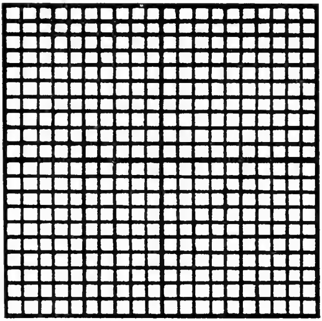


Fig. 82.

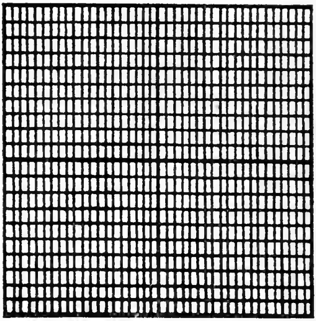


Fig. 83.

square inch as illustrated at Fig. 82 is modified and divided into 20 × 10 spaces as at Fig. 83, then where a solid tuft, loop or 'point' of colour is required it is simply painted over two of the horizontal spaces, but in case two singles have to be blended they are separately indicated, one in each space according to their respective colour and frame, so that the cards can be subsequently and correctly stamped and the colours lifted from the frames in which they are placed. It is not, however, *absolutely* necessary to employ specially ruled paper where only very small quantities of moresque effects are required. The ordinary size, 10 × 10, can be made to serve just as well if the designer paints *half* a square with the colour representing one of the

singles and the other half with a colour indicating its contemporary tone.

Colours working 'dead.'

When weaving in four, five or six frames, it frequently happens that for a given portion of the width of the carpet, some of the colours are not required on the surface of the pattern for the whole of the length; when this is the case the threads in such sections are said to be working 'dead' and are usually represented on the gamut as indicated in the fourth frame at Fig. 80. This makes it possible to introduce any old stock or odd bobbins of colour into this section and frame, which while it retains the full thickness of the carpet at the given point also uses up the old material.

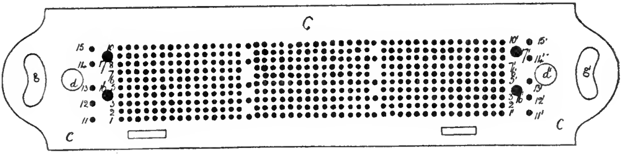


Fig. 85

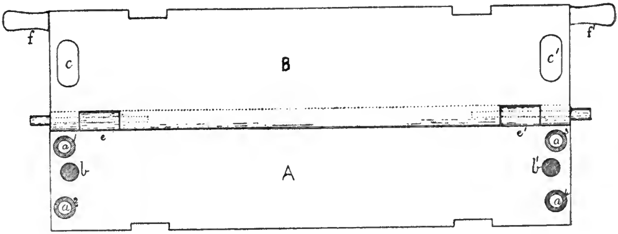


Fig. 84.

Card Stamping Machine for Brussels and Wilton.

There are several card stamping machines on the market for various classes of woven fabrics, but that used for punching the cards from designs for the above named carpets is the 'plate' combined with the vertically movable table, fully illustrated at Figs. 84 to 89.

There are three perforated plates A B and C; A and B are hinged together and C is detached as shown at Figs. 84 and 85. Two sizes of punches are required and these are shown full size at Fig. 86; the ordinary punch is represented at P and the punch for cutting the peg holes at PP.

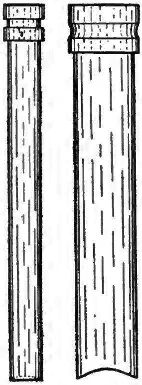


Fig. 86.

Fig. 87 is an elevation of the card stamping machine as viewed from the back.

Fig. 88 is an end section of the left hand side of the diagram.

Fig. 89 is a plan of the lifting table on which the plates A B C are placed.

Each plate is perforated so as to exactly coincide with the number of holes in a six frame jacquard cylinder with additional holes for lacing the cards together and cylinder or peg holes to enable the cards to fit and maintain their relative position with the card cylinder.

Commencing with the plate A, there are four large stud holes a^1, a^2, a^3 and a^4 which fit on four studs 48, 49, 48^1 and 49^1 respectively, in the lifting table Fig. 89; these serve to keep the plates from moving about when on the table 44; two upright studs b and b^1 fit into holes c and c^1 in plate B, and d and d^1 in plate C respectively, and by this arrangement the plate C is kept in perfect relation with A and B; the plate B being hinged to that of A as indicated at e and e^1 necessarily maintains the same relative position whenever it closes

over that of A and it is conveniently moved about the points e and e^1 by the aid of the projecting studs f and f^1. In every other respect the holes in all the three plates are exactly alike; they are shown complete in the plan of plate C Fig. 85.

At the left hand of punch plate C it will be observed that there are five small holes 11, 12, 13, 14 and 15, which are for punching the lace holes, next follow the peg holes 16 and 17; then there are fifteen full rows of holes, as 1 to 10, another row of lace holes, next, fourteen rows of full holes, one more row of lace holes, again, fifteen full rows of holes, and then the peg and lace holes on the opposite side. Near the ends of the plate there are finger holes g and g^1 for the convenience of lifting it into and out of the card stamping machine by hand.

These plates are made so that they can be used either for five or six frame cards. When required for the latter the whole of the holes 1 to 10 are employed and the card is punched for lacing through holes 11, 12, 14 and 15, but when five frame cards are stamped the rows 1 and 2 are left unused and the lace holes are stamped through 12, 13, 14 and 15 holes. When this is necessary the first two rows of cords B, in Fig. 40 are removed; there is also a division in the needle plate F just below the first and top two rows of needles; when these are lifted out of striking range of the card cylinder, the six frame cylinder with ten holes can be replaced by the five frame cylinder with eight holes.

The following is a description of the principal parts of the card stamping machine:—Two main supports 21 and 22 are held rigidly together by two iron adjustable rods 23, one only being shown, the other is immediately behind it and on the opposite side of the frame work; an iron punch box 24 is secured by bolts and nuts to the top part of the framework; a short shaft 25 is supported and free to revolve in two sleeves 26 and 27, the latter forms part of the bracket 27; the shaft 25 contains a fast and loose pulley 28 and 29 respectively and a small pinion wheel 30 is secured to it which gears into and is free to turn a large spur wheel 31 on the shaft 32, this shaft passes through and is supported in framework as shown; it carries two fast pinion wheels 33 and 33^1 which gear into two spur wheels

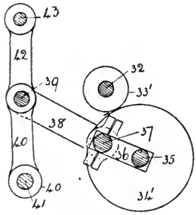


Fig 88

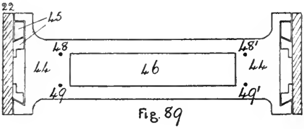


Fig. 89

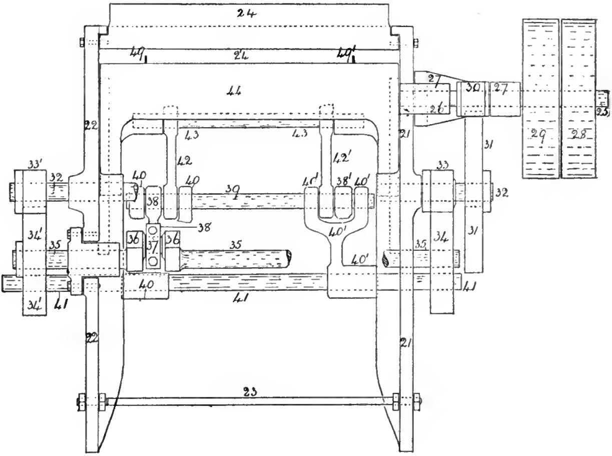


Fig. 87.

34 and 34^1 respectively, on the opposite ends of a crank shaft 35, so as to ensure more positive driving of the latter shaft. In some of the older machines eccentrics are employed in lieu of this crank shaft. The cranks are shown at 36, the crank axle at 37, and the connecting link at 38 joins it to a swing shaft 39; a second connecting link 40 is placed upon and free to oscillate about the fixed shaft 41; this link has two arms through which the swing shaft 39 passes and on which it is also free to oscillate; a third connecting link 42 combines swing shaft 39 with the shaft 43 about both of which it is free to oscillate; shaft 43 is carried in suitable bearings of the table 44; this table is free to move upwards or downwards being supported between the frame sides 21 and 22 and secure from any lateral movement by the arrangement of guides 45 as shown in the plan at Fig. 89.

The space marked 46 is to allow the small discs of paper punched from the card to fall through into a box prepared to receive them; 48, 48^1, 49 and 49^1 are four studs in the table to receive and hold the plates A.

Preparing and Punching the Cards.

The plate C is lifted into position above the punch box 24. The card stamper then reads from the point paper design and inserts punches into this plate in accordance with the pattern as explained on page 98.

After all the punches have been placed into their proper position in the plate C, a blank card is placed between the two plates A and B; the correct position of this card is determined by the two studs b and b^1 whose distance apart is exactly the same as the length of the card.

The plate C is now placed immediately over the plate B with the holes d and d^1 over the studs b and b^1 respectively. The relative position of the plates is then such, that the punches in plate C will pass through corresponding punch holes of plate B and rest upon the card which is between A and B so that whenever a sufficient pressure is applied to the heads of the punches, to press their lower ends through the jacquard card it will be perforated exactly as required by the pattern.

This machine is driven by power exclusively and the action of the mechanism is as follows :—By moving the belt from the loose to the fast pulley, motion is imparted to the shaft 25, pinion 30, spur wheel 31 and shaft 32. Pinion wheels 33 and 33^1 in turn revolve the crank shaft 35 ; with the revolution of the crank its connecting link 38 operates upon the shaft 39 together with the link 40 until they in combination place the link 42 in its most upright position and thus elevate the shaft 43 together with the table 44 and the plates A B and C with their punches, until the heads of these punches come into contact with the underside of the punch box ; since this is a fixture, the resistant force which it exerts causes the lower ends of the punches to press through the cards and the holes in plate A. The machine is then stopped and the cut card withdrawn. If several cards are required of the same plan, either for the given design or for several sets of the same pattern, the operation is repeated until the required number of cards has been cut, otherwise the punches in the plate C are modified to suit the colours which have to be lifted over the next wire. It is usual and best to cut the coloured design into sections to suit the three divisions in the jacquard card cylinder and then to stamp them separately.

Cross Border Jacquard.

In all cross border patterns such as are referred to in Chapter I and illustrated at Figs. 19 and 20, two sets of jacquard cards are stamped according to pattern ; the first contains the body, the second—the cross border.

All such figure designs can be woven either on the ordinary jacquard machine with one card cylinder, or by the aid of a cross border jacquard with two card cylinders. When the former is used, the first set of cards with the border is woven with one repeat. This is then taken down and replaced by the second set of cards containing the body, and woven for any desired length or repeats of pattern.

As an alternative method of frequently changing the cards, the following is an example showing the usual plan adopted in most parts of the country for weaving a 3 × 3 yards square of carpet on

a $\frac{3}{4}$ loom with an ordinary single cylinder jacquard machine. The principle for weaving other sizes is virtually the same. Three sets of cards are employed—one for each loom or arrangement of colours in the frames.

The first set contains the right hand corner and border.

The second set contains the foot border and filling.

The third set contains the left hand corner and border.

The order of weaving is as follows :—

I. Right hand corner and border.

Weave 270 cards of corner and as much of the border as is necessary; see Figs. 19 and 20, pages 44 and 45; next, two repeats of 270 cards of side border; then turn the cards back to number 270 of the corner border and weave these cards in the reverse order to number 1 card which thus completes this sectional length of carpet.

II. Foot border and filling.

First weave 270 cards of foot border and filling, next two repeats of filling, then the foot border cards backwards as above.

III. Left hand corner and border.

Weave exactly as for number I.

In this way the operation is repeated until as many rugs and squares of carpet have been made as are required. The objection to these methods is the waste of time caused through frequently changing or reversing the cards, during the whole of which period the loom is of course at a standstill, but when the demand for the woven material is small, manufacturers prefer to contend with such inconveniences rather than introduce more complicated machinery. When, however large quantities of cross border fabrics are required and where a good cross border jacquard machine can be obtained, it pays (in the course of time) to adopt it.

An outline of the Chlidema cross border jacquard is given in the few succeeding pages. As a piece of mechanism and an invention it is ingenious and suggestive of a wise attempt to overcome the difficulties experienced in carpet manufacture, which are otherwise absent in cross-border fabrics of less complicated structures

and where there are opportunities for employing a simpler kind of mechanism. The *essential* features of this invention are herewith set forth in general terms, without any attempt to detail the construction of the operating mechanism, it being the writer's aim to

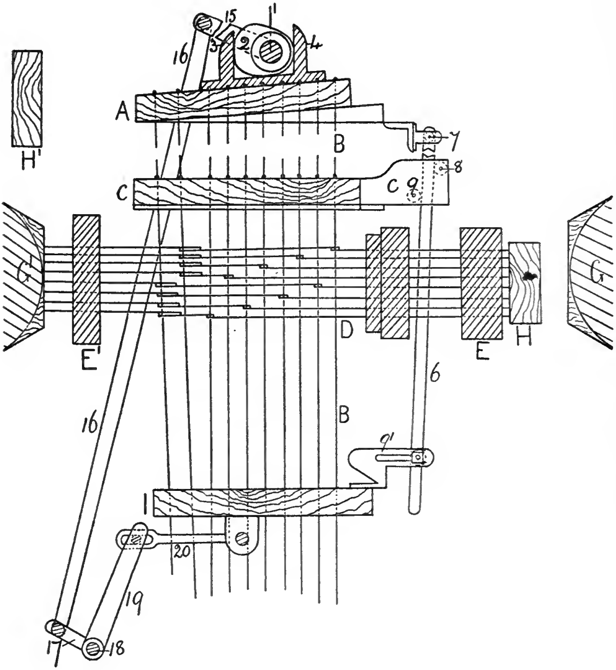


Fig. 90.

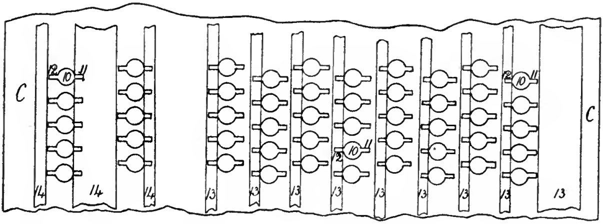
deal chiefly with those parts of carpet manufacture which are of general and absolutely essential application.

The modifications of the ordinary jaquard machine to produce cross border designs will be best understood by referring to Fig. 40

page 86 and considering any explanations and illustrations here given in connection with that part of the jacquard machine hitherto fully described. The letters in that and the following diagrams refer to similar parts.

Fig. 90 represents a vertical section of the suspension board A, figuring cords B, lifting or trap board C, needles D, card cylinders G and G¹, levelling boards H and H¹ and guide board I.

Fig. 92.



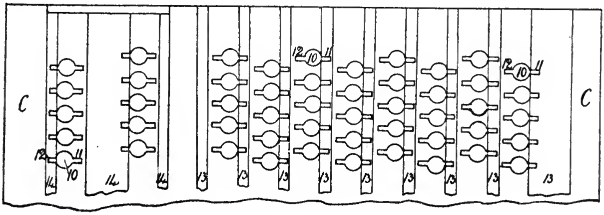


Fig. 91.

Fig. 91 represents a plan of the lifting or trap board C, when the front card cylinder is in action, together with a series of horizontal and parallel bars called 'shields' to be referred to later.

Fig. 92 shows a plan of this same board when the opposite cylinder is working.

The harness cords B are suspended as in Fig. 40 from the suspension board A, through perforations in board C as in plan Fig. 91, then continued through the needles, in the usual way, as shown and through the guide board I to the mails and lingoes.

There are two card cylinders, G at the front and G^1 at the back of the loom. The former with its cards controls the body and side borders of the carpet and the latter controls the cross borders and the corners.

Mechanism is designed to bring into action one card cylinder and simultaneously throw out of work the opposite cylinder together with its cards.

The plate F as in Fig. 40 is replaced by a needle plate E^1, a duplicate of plate E; there are two levelling-up boards H and H^1 which are so controlled as to be in and out of action, according to which card cylinder is striking against the needles.

An oscillating shaft I^1, capable of making half a revolution in either direction supports and moves a cam 2 between forks 3 and 4 of a bracket securely fastened to the suspension board A. This board is free to move along the jacquard frame 5, in sympathy with the oscillation of cam 2. To the oscillating shaft I^1 a crank 15 is secured; a connecting rod 16 joins this to a crank 17 on a counter-shaft 18 which runs from side to side of the jacquard and supports at each end a crank similar to that shown at 19. This crank 19, through a link 20 and studs as shown is free to move slightly in a lateral direction the guide board I, in harmony with the oscillation of the shaft I^1. All the necessary reversing motions are obtained from this shaft.

A hanging lever 6 from the stud 7 passes between rollers 8 and 9 in lifting board C and behind the needle plate E to the bracket 9^1 securely fastened to board I. Thus with the simultaneous movement of suspension board A, the guide board I moves laterally in the same direction, and this through bracket 9^1 and lever 6 operates on lifting board C and thereby moves it in the same direction as I but not quite so far. Therefore boards A, C and I, cords B and needles D are all free to move laterally in either direction and into working contact with either the front or back card cylinder at will.

An important feature in this mechanism is the lifting board C shown in plan at Figs. 91 and 92, and which should be compared with the plan given at Fig. 41.

In the former instance there is only *one* trap for lifting the cards but in the latter, on each side of the large hole 10 (through which the knot in the harness lifting cord B can pass) there are *two* traps 11 and 12, the object of which is to enable whichever card cylinder is operating upon the needles to press the knots of the harness cords over the trap in board C with whose elevation they are lifted. But in order to prevent the cords from getting across or into the wrong traps a number of long parallel iron bars 13, called 'shields'—one for each row of holes—are arranged so as to cover over the trap holes on one side only. These bars are arranged at such a distance from each other as to coincide with the distance apart of each row of holes; they are fixed at their ends to the jacquard supports and consequently the top lifting board C is free to move under the stationary bars, until they cover the trap holes on the opposite side, with every change from one card cylinder to the other. The alternative position of these bars or shields is shown at Fig. 91. But since the sixth frame is always 'on' *i.e.* the knots in the harness cords B are nominally over the trap, it is necessary to move either this section of the harness board C further than the other part or otherwise move the shields 14 over these rows independent of the rest in order that the knots may be over traps on the opposite sides of the large hole 10. The plan adopted is to move the board C as described and also to construct the shield part independently of the rest and move it at the same time and in the same direction as the board C but a little further so that the bars 14 shall cover the traps of the sixth frame in which the knots are not required to catch.

In the foregoing system, the modification of the trap board together with the necessity of having to move in a lateral direction the suspension, lifting and guide boards, needles and harness cords, involves the displacement and substitution of too many parts in the ordinary jacquard to merit general favour and acceptance.

A Suggestion. Effectiveness combined with simplicity are the two chief factors which must characterise any mechanical contrivance before it will be generally adopted. A suggestive arrangement of mechanism which can be applied to the *ordinary* Brussels and Wilton jacquard machines for weaving cross

border carpets, and which fulfils the foregoing requirements is illustrated at Fig. 93. This figure represents an end view of one row of needles and harness cords and also vertical sections of the needle plates, suspension and trap boards and card cylinders. The addition of this mechanism involves no remodelling or displacement of any of the usual parts.

The suspension board A, harness cords B, trap board C, needles D and plates E and F together with the card cylinder G are all exactly the same as shown in Fig. 40, page 86.

The additional mechanism consists of an extension of the cross wires D as illustrated at M. To avoid any reconstruction or sub-

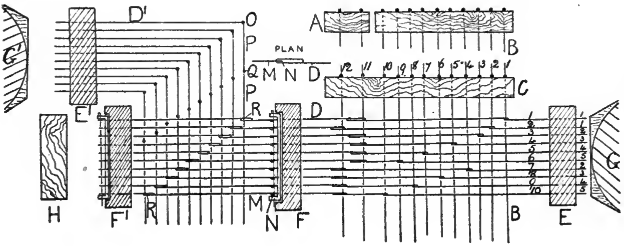


Fig. 93.

stitution of needles D the wires M are fastened by simply hooking them each respectively, to the loops which are already formed in the needles D outside the plate F at the position N; this will be seen to better advantage in the plan above. The cross wires M now pass through a terminal plate F^1 which retains them in position and which is, in turn, held by two brackets.

A second set of needles D^1 are passed through and partly supported by a needle plate E^1 which is supported by two brackets projecting from the jacquard uprights. The ends of these needles project through the plate E^1 as shown; their opposite ends are suitably connected by small pins O which pass through the upper arms of balk levers P. Each row of balk levers is supported on small steel pins Q about which they are free to move; these are set a

sufficient distance apart as to permit of perfect working without interfering with each other. The lower arms of P pass through and near the left hand side of the long loops R formed in the cross wires M as indicated. This allows the ordinary card cylinder to perform its work without in any way interfering with the needles D^1 and levers P.

The balk levers P are fulcrumed exactly midway between the points of application O in needles D^1 and their points of application R in cross wires M. The result of this arrangement is that the needles D move precisely the same distance, whichever cylinder is working.

The second card cylinder G^1 contains the cross border cards and is free to strike against the needles D^1. One levelling board H only is required which is set behind the needle plate F^1 as shown and is free to act upon the needles M and through these on the needles D and thereby press them back into their original and normal position immediately after each card cylinder has released the pressure on them.

Then as the unperforated part of the card is pressed against any of the needles D^1, they in turn are forced inwards to the right and turn levers P clockwise so that their lower arms operate through the loops R and move the needles M to the left, *i.e.*, in exactly the same direction as do the cards which are working on the ordinary card cylinder G. It is not proposed to treat in detail the mechanism which controls the card cylinders beyond that explained for the single cylinder in Fig. 40.

The almost universal plan of using one card cylinder and of changing the cards or reversing them will meanwhile continue to be practised until some such method as the foregoing is adopted.

Lubricating Brush and Support for Wires.

A very great amount of heat is generated in the wires during their extraction from the carpet, chiefly due to their frictional contact with the loops and especially is this the case, when the pile threads are cut as in Wiltons and Velvets generally. It is necessary therefore to lubricate the wires and to do so in such a manner, as

not only to reduce to a minimum the frictional contact, but also to prevent the oil from staining the rug or carpet.

The essential features of the brush and its arrangement are illustrated at Figs. 94 and 95. The former shows an elevation and the latter a plan. The chief feature is a revolving brush which is saturated with the lubricant solution; through the fibres of this brush the wires are drawn during the period of their extraction. At the same time the brush also serves the purpose of a support to the wires, in fact without its aid, some additional support would be necessary other than the parts explained under wire motions. The

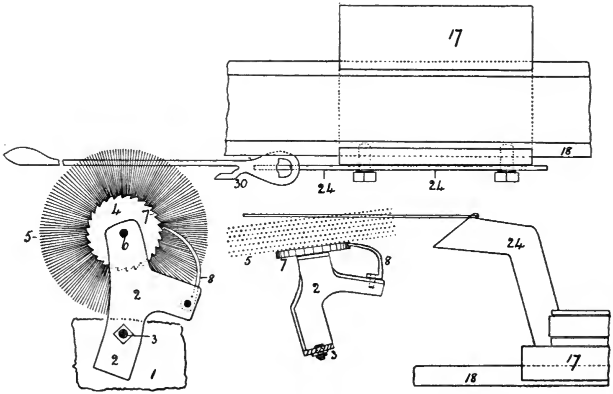


Fig. 94. Fig. 95.

following is a description of the whole contrivance, which, though simple is very effective.

A portion of the top front rail is shown at 1; to this a short, shaped bracket 2 is secured by a bolt and nut, indicated in the position 3; near the upper end of the bracket a brass disc 4, containing the circular brush 5, is centred and free to revolve about the point 6; the periphery of the disc is serrated with ratchet teeth 7 into which the upper end of a small wire pawl 8 fits, its chief work

being to prevent the brush from revolving during the extraction of the wire. The brush can be turned the opposite way by hand at will. The Wilton wire is shown at 30, the hook box at 17, the slide for same at 18 and the hook which pulls out the wire at 24. A compound of tallow, stearic acid and linseed oil produces a good lubricant, a solution of which leaves no stain after use.

There are numerous contrivances for producing special effects and for purposes of economy (real and otherwise) but many of these specialities are the exclusive property of individual firms and if they were not so their application, would in many instances, still be confined to the sphere in which they originated.

CHAPTER VI.

Tapestry Carpets.

A TAPESTRY carpet is essentially a pile fabric and is classified as such. Compared with its contemporaries it is simple in construction, economical in weaving and in the quantity of the figuring material used, owing to there being only one pile figuring thread as compared with five or six in Brussels and Wilton. It is however expensive in the process of dyeing or printing the loop yarn, whether before or after weaving, according to the method adopted. This is the chief factor in Tapestry carpet manufacture and is most important since it involves greater scientific and technical knowledge of the persons engaged in the several ingenious processes, than is the case with most other kinds of carpet manufacture.

There is virtually no limit to the number of colours which can be used, but artistic feeling and reason, tempered with economy, retard any extravagance in the direction of multi-coloured effects. Within recent years there has been a vast improvement in taste as applied to colouring of Tapestry carpets, even though many colour schemes for such fabrics are still very showy and of harsh contrasts; but these are largely produced to satisfy the demands and tastes of such countries and people who select and order them.

The ordinary Tapestry carpet is composed of one ground warp, called the small chain which is usually cotton, a pile warp, generally worsted, upon which the pattern is always printed and a jute stuffer warp which lies in the centre of the fabric structure and thereby only adds weight and bulk to the carpet. There is only one weft which may be of linen, jute or cotton.

The weft like that for Brussels and Wilton is first steeped in glue size, which adds about a sixth to its weight and assists in stiffening the back of the carpet when dry.

The following particulars are suitable for a standard make of Tapestry carpet:—

Warp.

2 threads of $3/7^s$	Cotton for ground—all on one warp beam				
1 „ „	2/2/12 Worsted for pile	„	„	„	
2 or 3 „ „	15 Spindle, Jute for Stuffer	„	„	„	

$17\frac{1}{2}$lbs. Spindle including size—(Aberdeen basis).

Weft 6s linen. 16 shots per inch.

These threads of warp representing one repeat of the weave structure, are all grouped together and drawn through *one* dent or split in the reed. Each splitful is equivalent to one point or loop on the carpet surface and such a carpet generally contains 8 splits or points per inch. The number of splits used in a standard reed width of $28\frac{1}{8}$ inches is usually 216. Other numbers in constant use for the same width of carpet are:—210, 189, 176 and 162.

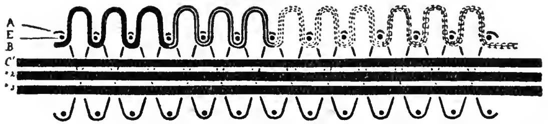


Fig. 96.

The structural principles of such a carpet are illustrated by a cross section through the weft at Fig. 96; the several markings on the loop thread represent different colours. The ground, pile and stuffer warps and the weft are all indicated respectively at A B C and E. There is only one pile thread and upon this the figured pattern is printed. The yarns used are approximately the same as those represented in the photograph at Fig. 29.

Several methods have been tried for producing the figure upon the loop material of these carpets viz:—

I. The pattern is printed, literally painted, upon the pile threads preparatory to weaving, due allowance being made for the subsequent reduction of the pattern by the interlacing of the threads and the insertion of the wires for the formation of the loops.

what is difference between III + V

II. The pattern is printed on the warp threads *collectively* and full width. In this process of printing, the design has to be made in an elongated form to allow for the formation of the loops. From such modified designs the printing blocks or drums are engraved.

III. The carpet is woven with the worsted loop yarn in the grey; subsequently the pattern is printed on the surface of the pile yarn by means of hand blocks, cylinders or other surface printing processes.

IV. The pile yarn is dyed the predominant light shade before weaving; the other shades are then successively printed on the loop yarn after the carpet has been woven.

V. The carpet is woven grey, then first dyed to the principal light shade and subsequently the other colours are printed on the carpet as required by the pattern.

The first method is the one most generally adopted, for by first printing the yarn according to pattern the colours become more impregnated with the loop material and so produce the best results in colour and design.

Further, a considerable saving is effected by being able to obtain any required pattern without the aid of expensive blocks, which are necessary for every separate and distinct pattern, with the adoption of any of the four last systems.

The method of first printing the pattern on single threads of pile yarn before being woven was invented by Richard Whytoch, a native of Edinboro' about the year 1832, since which date improvements of details have been introduced; the fundamental principles are virtually the same.

The subsequent operations of scraping, scouring, winding, setting, beaming, weaving, and finishing involve that the colours must be thoroughly fast if they are to retain their correct hue, tone or shade after being subjected to the agitation of these several processes.

The adoption of any of the other methods is in reality only a 'topping' process since it is impossible by any of the three last methods to cause the colour to reach to all parts of the loop yarn.

Consequently the carpet, though less costly in production is liable to show the undyed portions as is clearly indicated at Fig. 97. In this example the single loop yarn is represented by the different markings to be printed different colours, but at the base of each loop, underneath the top pick of filling, the loop yarn is shown

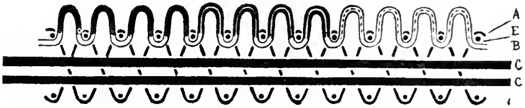


Fig. 97.

white, which represents the portion of figuring material usually unreached and undyed by the surface printing process. The structure, too, after being subjected to wear for a short time loses its ' topping ' and soon appears greyish.

Single Thread Printing.

Generally speaking a modern Tapestry carpet is woven with only *one set* of pile warp yarns, each thread of which is dyed of several colours along its entire length. Nevertheless the complete body of pile warp threads, exhibits varying colours across its width as well as along its length but these variations of colour are such and so placed that the simple predetermined tapestry fabric exhibits the desired pattern upon its face, even though the carpet is woven in a plain tappet loom with only a wire motion accessory. This accessory motion is the chief mechanism about the loom which need be described but previous to this a brief enumeration and summarised description of the preparatory processes may be given.

Their natural and progressive order is set forth in the following :—Scouring, stoving, steeping in cold water, drying, winding on bobbins, filling printing drum, printing, scraping, stripping the drum, steaming, winding for the setters, setting, beaming and weaving.

Preparation of the Yarn for Printing.

The worsted yarn is in the form of hank when received from the spinner. In this condition it is first thoroughly scoured in soap and water, then placed on sticks and stoved by being subjected to brimstone fumes in a suitable chamber; after this it is steeped in cold water from two to four days and then dried and wound on double headed bobbins preparatory to filling the printing drum.

Printing Drum and Printing.

General Description.

The printing drum is a large roller with an iron skeleton and a surface of wood. It is supported in a suitable framework having three separate bearings on which it can revolve. There are several sizes of drums in use, five, six and nine yards being among the chief; they are usually designated by the number of 'scrolls' for each circumference of the drum. A *scroll* represents *one* traverse of the printing pulley, in the colour box, across the face of the printing drum. The width of colour painted on the yarn by the printing pulley, is equivalent to one loop or wire in the cloth and consequently to one small horizontal division on the point paper. It requires about three inches of printed yarn to weave one inch of pile with eight or nine wires per inch, which is about $\frac{1}{3}$ of an inch of printed yarn to every loop and scroll; with six or seven wires per inch, two and a half inches of printed yarn is required. From these particulars the width of the scroll pulley is determined. The respective sizes of the drums in use are:—216, 324, 432, 648, 864 and 1072 scrolls.

Driving of the Drum by Power.

The drum is constructed so that it can be made to revolve by hand or power; the latter method is adopted for the purpose of filling the drum with the worsted yarn and the former for the printing operation or other purpose; the construction and arrangement of the mechanism is illustrated at Figs. 98 and 99 and may be described as follows:—The former is an elevation of the drum as seen from the driving end; the latter is an elevation of same as viewed from the side on which the printer works. A short counter shaft 1 is

supported at right angles to the drum A on the driving side. This shaft carries the fast pulley 2, the loose pulley 3, and the brake wheel 4. Near the opposite end of the shaft 1 as indicated is a small bevel wheel 5. This gears into a second bevel 6 on a second counter shaft 7 and parallel with the drum shaft. A pinion spur wheel 8 on shaft 7 gears into a large spur wheel 9 on the drum shaft 10, which latter passes through the centre of the drum A. Six spider or radial

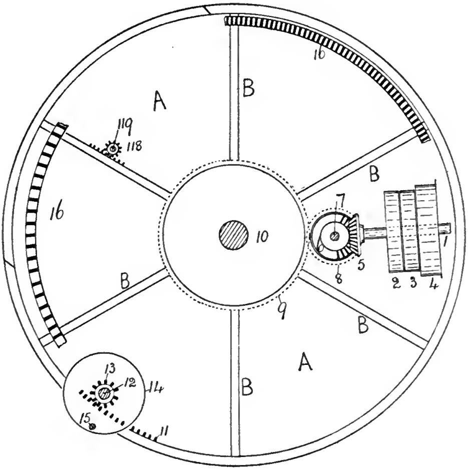


Fig. 98.

arms B project from the shaft 10 and have at their extremities cast iron arcs of circles to which the surface boards of the drum are secured. By the arrangement of the mechanism thus described, the drum can be driven by power, for by transferring the belt from the loose to the fast pulley, shaft 1 is turned, which, through bevel wheels 5 and 6 turns shaft 7 and this latter through the medium of spur wheels 8 and 9 revolves the shaft 10 with drum A to the left. An alternative

and more direct method is shown at Fig. 100 which system is chiefly adopted with the smaller drums. The same numbers in each diagram refer to similar parts.

Driving of the drum—by Hand.

The inside of the drum A in the position indicated at the driving end contains a circular rack 11. A small adjustable shaft 12 has fixed to it a small pinion wheel 13 and a hand wheel 14 with a suitable stud 15 for the convenience of turning the wheel with shaft 12;

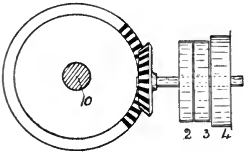
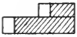


Fig 100

Fig 102



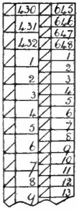


Fig. 101.

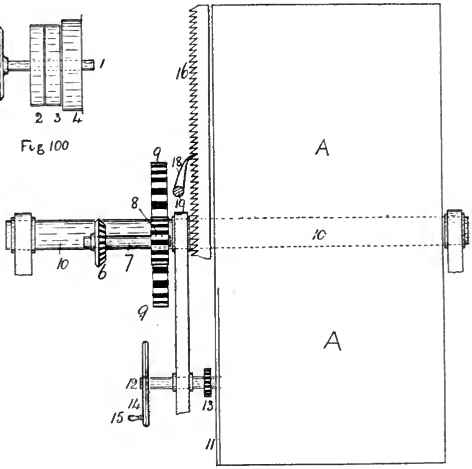


Fig. 99

the teeth of the pinion wheel 13 can be pressed into and out of gear as desired, thus permitting of the drum A being turned by hand at will. This method of driving is adopted during the period of printing, when changing from one index and scroll to another.

Indices of drum.

To each drum there are two indices—one fine and the other coarse; these are fastened to the spider arms of the drum as marked at 16; they

contain ratchet teeth whose number is equal to one or other of the scrolls referred to. A pawl or 'scotcher' 18, conveniently supported on stud 19 fits with its sharp edge against the base of any tooth which the printer may select. Every tooth on each index is consecutively numbered for the full circumference and represents the total capacity or number of scrolls which can be printed on any given drum, since the pitch of each ratchet just permits the drum to revolve a distance equal to the width of the scroll pulley. The two indices on each drum are for the purpose of enabling two different widths of scroll pulleys to be used and consequently of different pitches and lengths of pile being made. The coarser index is used with a broader scroll pulley when a greater loop or elongation of the pattern is required.

Portions of these indices or indexes are detached and numbered as shown at Figs. 101 and 102. The former is an elevation as seen from the front of the drum and the latter represents a transverse section, thus showing that both indexes are formed in the same piece of metal. The finer index contains 648 ratchet teeth while the coarser contains only 432; these teeth permit the use of scroll pulleys which respectively print 648 and 432 scrolls of colour transversely on the yarn to one complete revolution of the drum. But by using the odd or even numbers throughout on the finer index and numbering the design to correspond, a scroll pulley which covers the drum in 324 traverses may be employed instead of the 648.

Filling the Drum.

The method of filling the drum is shown at Fig. 103 which represents a side elevation together with the bobbin stand. Near the floor and placed immediately in front of the drum, but on the opposite side from which the printer stands and works, is a small frame 20, which is capable of holding six or eight (usually six) full bobbins containing the worsted material. The bobbins are shown at 21 to 26. Attached to the spindle of each bobbin, is a small tension weight, which can be lifted on or off the bobbin at will; during the operation of winding they always rest on the bobbins and thereby prevent them from over running. Tension is also applied to each thread by passing it over and under three tension bars not shown, so that as the yarn is

being wound on the drum it will not be slack. Immediately above these tension bars and above the stand 20 but jus below the centre of the drum is a straight rod 33 known in the trade as the 'guide bar'; this is supported in brackets;

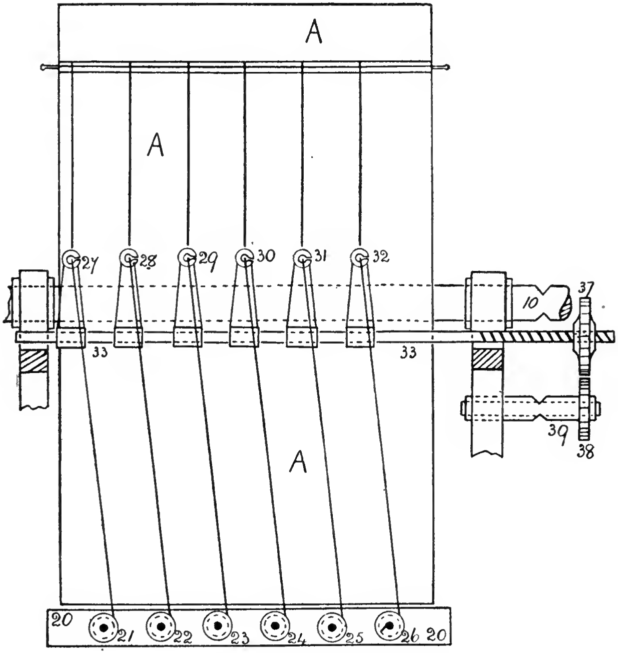


Fig. 103.

projecting upwards from this rod are six finger guides 27 to 32 inclusive or as many as there are bobbins in the stand 20. Each finger guide contains an earthenware eye through which the yarn can pass with a minimum amount of friction. The rod 33 is free

to move laterally in either direction by means of a worm as marked; a wheel 37 fits into this worm and also contains spur teeth around its periphery. Circular motion is imparted to this wheel by a pinion change wheel 38 on a sleeve shaft 39 and a train of wheels operated upon by a spur wheel or a band wheel on the drum shaft imparts the necessary circular movement to the sleeve shaft 39. This train of wheels also indicates with the aid of a small clock the number of revolutions of the drum and the length of material wound on it. Then with the constant revolution of drum shaft 10, shaft 39 and worm 36, the rod 33 is moved across the face of the drum. The speed of the traverse of carriage can be varied, according to the length of yarn required to be printed, by simply changing wheel 39 for another wheel with more or less teeth as circumstances may demand. Then the required sorts and counts of yarn are selected and wound from the bobbins on to the printing drum by young women who are designated 'fillers.' Their work consists in first covering the whole periphery of the drum with a sheet of oil cloth, the object of which is to prevent any loose colouring matter from getting on the face of the drum during the printing process and which might otherwise become assimilated with other colouring matters used in subsequent printing. Preparatory to printing, the filler places the six full bobbins on the slide carriage and then takes a treble piece of yarn and carries it about three times across the width of the drum and securely fastens it at each end. The ends of the threads from each of the six bobbins are now tied to the above piece of thick yarn, at equal distances apart, across the width of the drum which is then set in motion and continues to revolve, by power, until the required length of material has been wound upon it which is indicated by the clock already referred to. Simultaneously the sliding carriage travels with the six threads until the intervening space between each thread on the drum is covered with yarn. If less than a full drum is required, then by simply using 5, 4, 3, 2 or 1 bobbin, the width of the drum covered would respectively be $\frac{5}{6}$, $\frac{2}{3}$, $\frac{1}{2}$, $\frac{1}{3}$ or $\frac{1}{6}$. The filler then divides the number of threads which are around the drum, into six divisions each containing about 196 threads, a

number which corresponds with the numerical revolutions of the drum and also the number of bobbins used. Each of these divisions is tied separately and is called a 'hank.' A lesser or greater number of threads and length of hank can be made as desired; but it should be distinctly understood that the whole length of the yarn on the drum, represents *one* pile thread only.

Even distribution of the yarn over the face of the drum.

There are several methods in practice for driving the guide bar and imparting the necessary lateral movement to it; two only are here given, one of which is band driven and consequently somewhat negative in its action and in this system the clock or measuring arrangement is driven independently of the guide bar. The other method combines in the same mechanism the traverse of the guide bar and the clock index; it is positively driven by tooth gearing throughout and is of more modern application.

An automatic stop motion is connected with each thread immediately above the bobbin stand, so that if the yarn should break or run off, during its distribution, the revolution of the drum A is at once arrested.

First method.—Fig. 104 is a plan of the band drive.
,, 105 is an end elevation of same.
,, 106 ,, ,, ,, ,, the measuring apparatus.

The same signs in each diagram refer to corresponding details.

A portion of the framework is shown at 40, the drum shaft at 10, the band or small rope at 41; a stud 42 is secured to the frame 40; upon this stud a sleeve 39 is free to revolve; a **V** cut is formed in the sleeve at 43 and also in the drum shaft 10 at 44. The rope 41 fits into these grooves and is free to drive the sleeve 39 with the revolution of the drum shaft 10. This sleeve 39 carries the change wheel 38, which gears into the guide bar wheel 37. See Figs. 103 and 105.

In the measuring apparatus a single worm 45 is formed round the drum shaft 10; this gears into a worm wheel 46 fixed on a cross shaft 47 which is suitably supported by two brackets to the framework; near its opposite end it carries a spur wheel 48 which gears into and is free to revolve a second spur wheel 49 on a stud shaft 50

about which it is free to turn. The shaft 50 is carried by a bracket projecting from the frame supports. To the wheel 49 the indicator is attached and since the number of teeth in the three wheels, 46, 48 and 49 are the same, one revolution of the drum shaft and drum, moves wheel 49 through a distance equal to the pitch of one tooth,

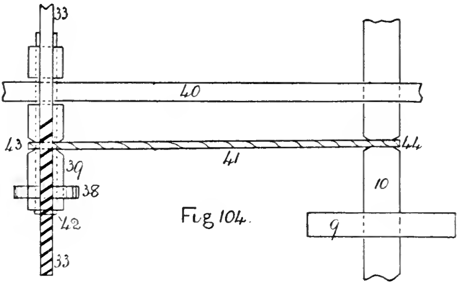


Fig 104.

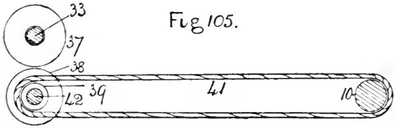


Fig 105.

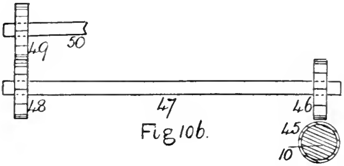


Fig 106.

consequently the product of the number of teeth through which the wheel 49 turns and the circumference of the drum in yards, will equal the number of yards of yarn wound on the drum from each bobbin and this length multiplied by the number of bobbins employed will give the total length of yarn, in yards, on the drum.

Second method :—Fig. 107 is a plan of the essential parts of this mechanism.
,, 108 is an end elevation showing the relation of the change wheel to the driving and guide bar wheels.
,, 109 is a front elevation of the worm and clock arrangement.

On the drum shaft 10 is a pinion wheel 51 which gears into and drives a small spur wheel 52 combined with a bevel wheel 53 on stud 54; the bevel 53 combines with 55 to turn shaft 56; this shaft is supported by two brackets 57 and 58; a bevel wheel 59 is

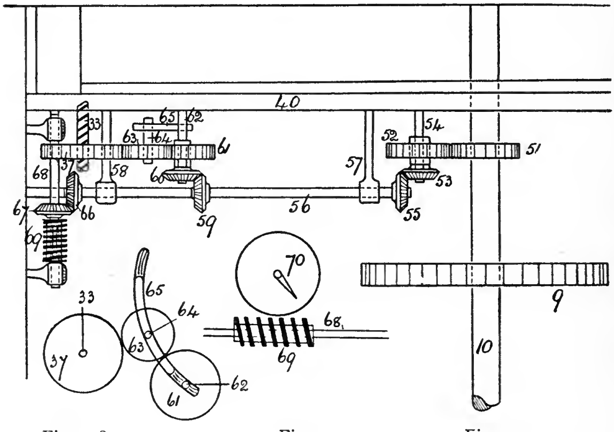


Fig. 108. Fig. 109. Fig. 107.

secured to the shaft 56 and gears into a second bevel 60 which is combined with the spur wheel 61 both of which are free to revolve on stud 62. The studs 54 and 62 and bracket arms 57 and 58 are individually secured to framework 40; the spur wheel 61 gears into the change wheel 63 which is on the stud 64 in a specially constructed and adjustable bracket 65; this change wheel 63 engages with the wheel 37 on the guide bar 33 Fig. 103.

The shaft 56 also carries a bevel wheel 66 which drives bevel wheel 67 on a counter shaft 68 supported by two brackets as shown

to the framework; the shaft 68 carries a single worm which gears into and drives a worm wheel 70 to which the clock is attached.

Then with the constant revolution of the drum, the spur pinion wheel 51 transmits motion through the train of wheels just described and produces not only the necessary lateral traverse of the guide bar 33 but simultaneously turns the clock wheel 70 through the index of which, the number of revolutions made by the drum, and the total number of yards wound on it can readily be determined.

The following example will serve as an illustration for either the first or second method :—

Assume a printing drum is filled from six bobbins and makes 150 revolutions. Find the number of yards of pile yarn on drums of five, six and nine yards circumference respectively.

1. 5 yds. drum = $5 \times 150 \times 6 = 4500$ yds.
2. 6 ,, ,, = $6 \times 150 \times 6 = 5400$,,
3. 9 ,, ,, = $9 \times 150 \times 6 = 8100$,,

Printing.

Prior to the introduction of the present process of printing by a roller revolving in the colour box, the colour was applied to the yarn as it lay wound on the drum, by means of straight, long and narrow wooden sticks covered with felt at the edges. The sticks were first dipped in the colour required and then applied to the yarns on the colour drum by hand. It is perhaps worthy of note that many attempts have been made to *automatically* print the colour on the yarn by a series of parallel bars or sticks, with felt edges; all such efforts have hitherto apparently achieved small success. The invention and introduction of the drum together with the scroll pulley has been a great improvement and is the factor which has contributed so largely to the general adoption of this process.

The printing part of the work is most difficult and requires very great care, for should a wrong colour be painted it would run all through the carpet on that particular thread for its whole length —perhaps 2000 yards, more or less according to the number of

repeats which are being printed. This might result in serious consequences for both the printer and manufacturer.

The mechanical operation of actually printing the required colour on the yarn as it circumscribes the periphery of the drum is

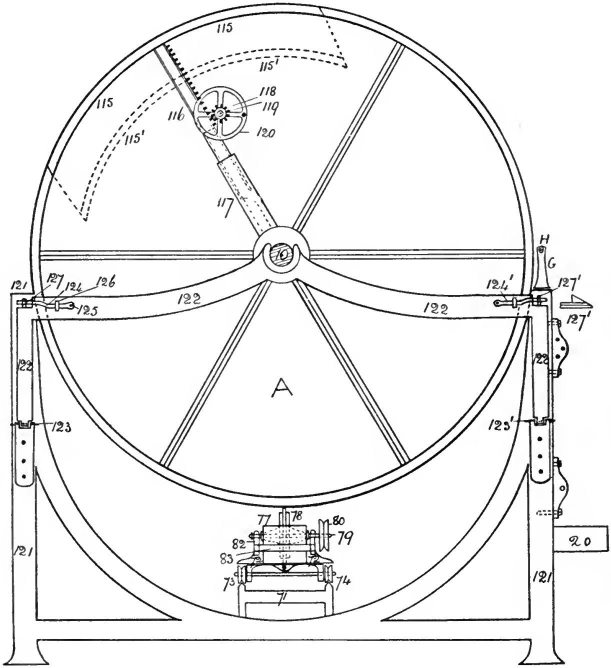


Fig. 110.

performed at the end of the printing drum remote from the driving end. The construction of the different mechanisms together with their combined action may be illustrated and described as follows :—Fig. 110 shows a vertical section of the colour scroll and box in

carriage on the railway lines in position immediately under the drum and the scroll pulley in close contact with it as seen from the end at which the colour boxes are changed.

Fig. 111 is a side elevation of the scroll pulley, colour box, carriage and railway combined.

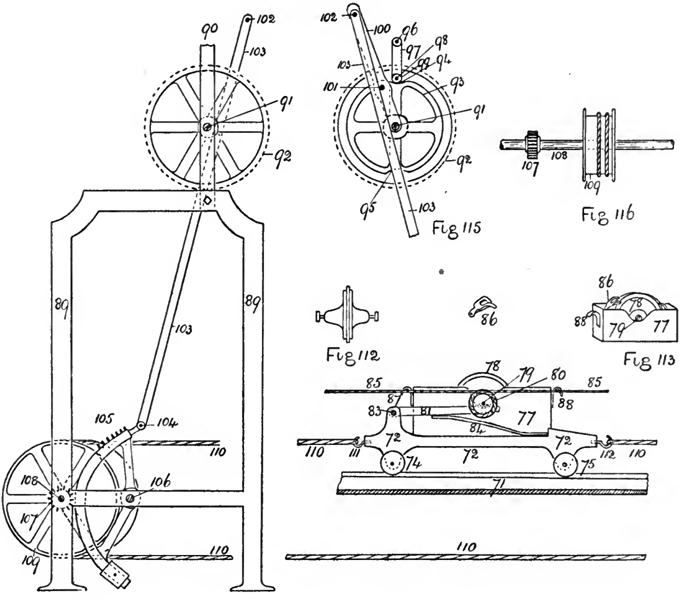


Fig. 114. Fig. 111

Fig. 112 represents a detached view of the scroll pulley.

Fig. 113 shows the scroll pulley and colour box combined.

Fig. 114 is an end view of the mechanism required to produce the 'to and fro' movement of the carriage. The whole of this mechanism is situated at the driving end of the drum.

Figs. 115 and 116 are detached parts of this mechanism.

The corresponding reference marks in each of the diagrams stand for similar parts.

The railway on which the carriage is supported and travels is shown at 71. It runs the full length of the drum and is adjustably supported by bolts and nuts at suitable distances apart along its length for the purpose of correctly adjusting the scroll roller with the drum. The track consists of two lines, a section of which is like an inverted **V** as will be seen in the illustration Fig. 110. The carriage 72 is a skeleton frame placed on four wheels 73, 74, 75 and 76. The colour box 77 filled with colour is placed in the carriage in the position indicated; the scroll pulley 78 rests in this box and through it runs a shaft 79 on one end of which is a small grooved pulley 80. The shaft of the scroll pulley is placed in the free ends of two short levers 81 and 82 on opposite ends of shaft 83 which shaft passes across one end of the carriage; a spring 84 is fastened to the base of the carriage and its opposite end exerts a constant pressure against the underside of lever 81; a duplicate is correspondingly arranged and is free to act on lever 82 on the opposite side, the result of which is to keep the scroll pulley in elastic contact with the yarn on the drum. An endless band 85 is coiled once round this pulley and then fastened to fixed supports at the opposite ends of the carriage traverse so that as it makes the journeys backwards and forwards the rope 85 causes the scroll pulley to revolve in the colour box and so impart to the yarn on the drum a constant supply of fresh colour; a small casting 86 rests on the periphery of the scroll pulley and prevents any excess of colouring matter being carried to the yarn as the scroll revolves; 87 and 88 are small handles to facilitate lifting the colour box into and out of the carriage.

The parts which produce the alternating traverse of the carriage are shown in Figs. 114, 115 and 116. 89 is a portion of the supplementary framework at the driving end of the drum; an extension 90 of this frame at right angles supports a stud shaft 91; this shaft contains a large spur wheel 92 which is free to revolve upon it. This wheel receives its motion from a pinion wheel on a clutch shaft not shown and the latter carries a single pulley on which the belt from the mill shaft is constantly running. A clutch on the

pinion wheel shaft referred to, but free to move laterally, can be put into and out of communication with the belt driven pulley at will, by means of a hand lever attached to it. A cam 93, joined to spur wheel 92 is also free to revolve on the stud shaft 91 and is recessed in two places 94 and 95 which are diametrically opposed.

A stud 96 carries a bracket 97 having a stud 98 near the bottom; an anti-friction bowl 99 is free to revolve on this stud and is kept in rolling contact with the cam 93.

A lever arm 100 is on and can revolve round the shaft 91; a stud 101 passes through this lever from the cam 93 by which means the lever is made to revolve; it projects beyond the stud 101 and carries near its terminus a stud 102; to this stud a connecting rod 103 is suspended and free to turn; the lower end of this rod is connected by a loose stud 104 to a segment wheel 105 which is centred and free to turn on stud shaft 106; the teeth of the segment gear into a pinion wheel 107 on shaft 108 supported in frame 89; to this shaft a rope pulley 109 is keyed and revolves with it; a strong rope 110 is coiled around this pulley, the ends of which are fastened to the hooks 111 and 112 at the opposite ends of the carriage 72. A pulley, around which the rope runs, is arranged at the opposite end of the drum from which pulley 109 operates.

The reciprocating movement of the carriage is obtained as follows:—The act of turning spur wheel 92 causes the motion of crank 100 to be transmitted through the connecting rod 103 to the segment rack 105 and pinion 107 on shaft 108 thus causing the latter with pulley 109, rope 110 and carriage 72 to alternate backwards and forwards along the full distance of the drum. The carriage is brought to a brief and perfect standstill at each end of its journey, when the anti-friction bowl 99 is in either deflection 94 or 95 of cam 93. This arrangement allows time for the printer to detach the clutch driving mechanism and to turn the drum by hand into position, ready for printing the next scroll.

Examples. Assuming that the size of the drum is equal to 648 scrolls and also that one repeat of the design to be printed, contains 216 pile threads and 324 wires and scrolls, then the design is cut into six longitudinal divisions which are each

equal to 36 threads of pile. The sections are pasted upon separate boards of similar size, varnished over and called the design or printing boards. These sectional boards are for convenience in handling and so as to enable different pile yarns belonging to the same carpet to be printed simultaneously but on separate drums of the same size and by different printers. Each printer has *one* board and follows *two* drums and to avoid any loss of time he prints on one while the other is being scraped, stripped and refilled. It is only possible to print *one* pile thread at a time, consequently each thread requires a separate drum and each board will therefore represent 36 drums or *each* drum must be filled 18 times, so that when the printer has finished his board he has only printed 36 threads or $\frac{1}{6}$ of the whole design; he has, however, printed a considerable number of repeats of pattern on each thread, which may be predetermined by the size and proportion of the drum filled, as may also the length of carpet which this thread will subsequently run through.

Then, as in the foregoing example there are 648 scrolls to 324 wires, the design will repeat twice to each revolution of the drum. In order to make this section thoroughly clear or manifest, let it be assumed that the yarn is wound from six bobbins on to a printing drum of 648 scrolls and that the drum makes 192 revolutions in filling. If the carpet has to contain 7 points or wires per inch, what length of carpet would this thread be equal to and how many repeats of pattern would the thread contain, assuming that one repeat of the design contains 324 wires?

1. Then since each scroll represents 1 loop or wire, 648 scrolls equal 1 revolution and 648×192 equals the total number of scrolls for each bobbin, but since there are six bobbins then $648 \times 192 \times 6 = 746{,}496$ = the total number of scrolls or loops in the whole length of yarn on a full drum of 192 revolutions; consequently

$$\frac{\text{Total scrolls in the full length of yarn}}{\text{Scrolls or loops in one yard of carpet}} = \text{Length of Carpet.}$$

$$\text{Thus:—}\quad \frac{648 \times 192 \times 6}{7 \times 36} = 2962\tfrac{2}{7} \text{ yards of carpet.}$$

(when each of the remaining threads in the whole design is similarly treated).

2. Obviously the total number of scrolls in the whole length of yarn on the drum divided by the number of scrolls or loops in each repeat of the design represents the total number of *repeats* of pattern for each printing and for each thread.

$$\text{Thus;—}\quad \frac{648 \times 192 \times 6}{324} = 2304 \text{ repeats of pattern.}$$

The printer has a scale board which he can affix to his printing board in such a manner as will permit him to move his scale across the printing board at will.

Scale Board. There are several scale boards in use, made to suit the different pitches of design paper. Thus, for a design prepared and coloured on point paper which contains seven points per inch, the scale board is marked into divisions of seven per inch throughout its entire length so that each division on the scale will therefore coincide with each horizontal division in the design paper, wire or row of pile in the carpet, and index on the drum.

A portion of a scale board is shown at Fig. 117. It contains seven divisions per inch along its length, is consecutively numbered from top to bottom, and has a bevel edge on one side as shown in the section beneath. It is intended to be used for a quarter board design *i.e.* a design which repeats four times to one revolution of the printing drum. The size of the drum is 648 scrolls and the number of wires in one repeat of pattern is 162. Therefore the scale contains four divisions 1 to 162, 163 to 324, 325 to 486 and 487 to 648.

Printer's Board. A portion of the printer's board containing 14 threads of the design, on paper 7 × 7, is given at Fig. 118. The respective colourings are indicated by the different heraldic colour signs. When the designs are long they are cut in two for convenience. The scale board is then placed over the design board in such a position that the edge of the bevel is close up to the first or any thread which is being printed.

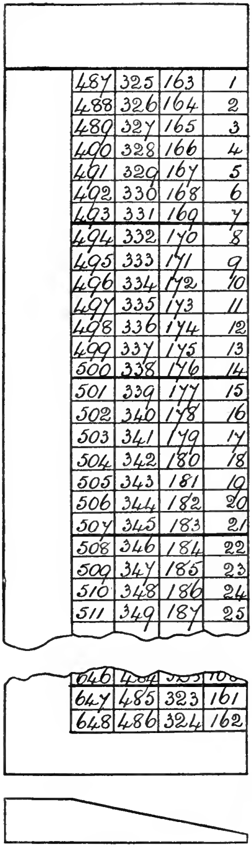


Fig. 117.

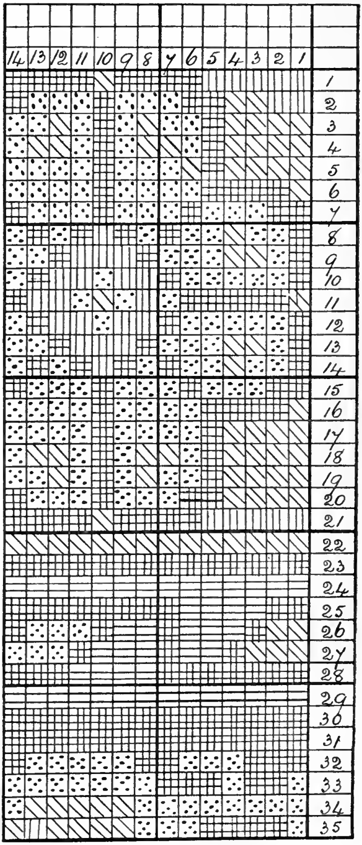


Fig. 118.

The colour used for printing on the yarn must be of such a consistency that it will not run. It is a mixture of pigment colour flour and water. For each colour in the carpet there is a separate colour box. These are filled by a youth whose duty it is to place each box of colour in the carriage as required by the printer as well as to keep the boxes filled with colour.

Then having got all the colours required the printer begins to print, literally paint, commencing first with the lightest colour, then the next nearest in tone and finally finishing with the darkest shade of all *e.g.* If the first loop of lightest colour is opposite number 10 division of his scale board, the printer accordingly turns the drum and sets the pawl 18, under the index numbered 10. The colour box then travels under the drum, and the scroll revolving in this box and colour, is kept in rolling contact with the drum as it travels across the width of same, thus leaving its impress of colour on each thread which circumscribes the drum. Then if this same colour next occurs opposite the sixteenth division on his scale board, he accordingly turns the drum and fixes the scotcher opposite the corresponding index number. Then the colour box with the scroll returns across the drum and prints the same colour as before on *each* thread of the drum. If there should be an odd number of scrolls of any given colour, the printer runs the colour pulley back on a former print of the same colour.

The printer thus proceeds until he has travelled from the top of his board and printed this colour on the worsted wherever indicated by the design on this same thread; but since one revolution of the drum is usually equal to twice the number of scrolls in one repeat of the design the printer proceeds to print this thread over again on the second half of the thread until the drum has completed its revolution; such a board is therefore called a "half board." Whenever the number of scrolls in one revolution is equal to 3 or 4 repeats of the pattern then each thread on the printing board must be accordingly printed 3 or 4 times until the drum has completed its revolution; in such cases they would be styled a $\frac{1}{3}$ or $\frac{1}{4}$ board.

Afterwards the colour box and colour are changed and the process is similarly repeated for this and each subsequent colour as they

proceed towards the darkest of all, and until all the yarn is completely painted.

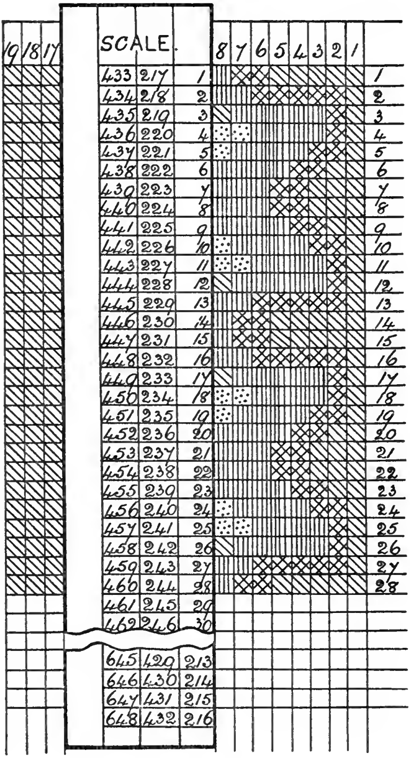


Fig 119.

The printer then moves his scale board to number 2 thread and proceeds as above to print this thread on his second drum whilst the first is being scraped, stripped and refilled.

Scale and Design Board Combined.

Fig. 119 represents a portion of the design board (8 × 8) and scale combined. The numbers along the top indicate the pile threads in the design and subsequently of the carpet, reckoning from the right; they also indicate the drum number which is being printed. The numbers down the right side represent the loops or wires in the carpet and one scroll in printing and those on the scale board coincide with these. The full design contains 216 loops and the index of the drum is 648. The design on each thread will therefore repeat three times to one revolution of the drum. The scale selected has three divisional sets of numbers, viz.:—1 to 216, 217 to 432 and 433 to 648; for the first, second and third repeats of the design the printer uses the first, second and third divisions on his scale respectively. In this illustration the scale is placed opposite the eighth thread and the printer is now supposed to be printing his eighth drum.

The lightest colour is yellow and he accordingly prints this colour first wherever required through the full length of the design. This colour occurs first on the fourth horizontal line; the printer therefore turns his drum by hand and places the pawl in the index number 4. The colour box being placed in position, he sets in motion the carriage containing it and prints the scroll 4 as described. He then turns to the index 5 and paints another scroll of the same colour as required by the design. Reading down the portion of design board shown it will be observed that this colour occurs on the 10, 11, 18, 19, 24 and 25 horizontal rows; the printer therefore places the scotcher into the corresponding index numbers and prints each scroll of yellow separately. The remaining colours are successively printed in the order of their delicacy as stated.

Whenever any of the pile threads are required of one colour throughout as is represented by the first thread which is all green; the thread is printed by the scroll pulley as ordinarily and not dyed as some would imagine.

When the drum is only partly covered with yarn, the colour pulley can be removed from contact with the yarn on the drum at any required point of the traverse so as to cease printing when necessary.

Scraping the Colours.

When the colour is rolled on to the yarn as it circumscribes the drum, it does not thoroughly penetrate the whole of the thread and fibre right to the drum. Consequently some method must be adopted that will thoroughly saturate the pile yarn with the colouring substance. This desideratum is satisfied by the simple operation of 'Scraping' which is a two-fold process since it not only satisfies the foregoing requirements but also removes from the yarn all superfluous colouring matter.

The process of scraping is performed by the fillers who use a small vulcanite instrument of the shape as indicated at Fig. 120. They are made generally in four sizes and vary from ½ to 2 inches

Fig. 120.

in width, to suit the width of scroll. The scraper scrapes each scroll or colour separately, and afterwards thoroughly wipes the instrument before repeating on the next colour and in such a manner the operation is continued until the whole of the colours have been scraped. To each full drum *two* women scrapers are employed in accordance with the rules of the printers and fillers, which states that "a filler must have a helper for all drums over four hanks." In front of the drum on the filling side there are two upright brackets G, Fig. 110. A steel bar H fits into these across the front of the drum which serves as a guide for the scraper so that she can scrape the colours in a perfectly straight line.

Stripping.

The process of taking the printed yarn off the drum is known technically as 'Stripping.' It is important that the yarn be stripped off in hank form and in order to accomplish this, the drum is specially constructed as illustrated at Fig. 110. The drum is represented at A and the central shaft

at 10. A section 115 of the drum A is supported independently on two of the spider arms 116 and its duplicate 116^1 which together with the drum segment are free to move nearer to the centre of the drum as indicated by the dotted arcs 115^1 and also back again to their present position. The spider arms are each in two parts 116 and 117 with their duplicates 116^1 and 117^1. The upper parts 116 and 116^1 contain a number of spur teeth as shown; into these teeth a rack pinion 118 gears; the pinion is on a shaft 119 which is suitably supported on two brackets and a hand wheel 120 is made fast to it by which means it is made to revolve. This shaft 119 passes to the opposite end of the drum, where it carries a corresponding pinion to that number 118 which gears into the rack of the duplicate spider arm to 116.

The act of revolving the shaft 119 through its pinion wheels and their gear with the teeth in spider arms 116 and 116^1, together with the drum section 115 causes the arms and section to be lowered or raised in the slides of the fixed arms 117 and 117^1 as desired.

An additional feature in connection with stripping is that a part of the frame supporting one end of the drum shaft 10, sometimes called the 'leaf,' can be pulled down towards the stripper, so as to allow the yarn on the drum to be taken off in one large hank. The chief features of this arrangement are as follows:—The leaf 122 consists of two uprights and a cross piece as shown; the upright arms of the leaf are hinged to the framework 121 in the positions 123 and 123^1. On the crosspiece at the top of each arm is a small latch 124 and 124^1 pivoted at 125 and 125^1 and passing through guides 126 and 126^1. The free end of each latch passes behind catches 127 and 127^1 respectively. A side view of the catch is separately illustrated on the right hand side. With the foregoing arrangement the latches can be lifted clear of their respective catches and this permits the leaf 122 to be pulled forward—as above. Provision is made at the opposite end of the drum so as to prevent it from tilting over whenever the support 122 is released.

The segment 115 of the drum being first lowered, the strippers, who are usually men, then place two long sticks under the oilcloth and so lift it together with the yarn clear of the drum.

To each hank is fastened a ticket, or 'tally,' with a number on it. This number corresponds with the number of the pile thread on the design paper from which the printer has selected his colours.

Steaming.

The yarn after being stripped is placed on a net work of string secured to four sides of an iron frame. A series of such networks in frames are arranged in tiers upon an iron carriage; a complete carriage contains about 30 hanks or drums, which is wheeled into a large double walled iron steam box; this box is then securely closed and bolted to prevent any escape of steam. The temperature is kept very high and there is a considerable pressure of steam both in the inner box and also in the cavity between the iron shells. The combined action of the heat and steam pressure tends to permanently 'fasten' the colours. The operation lasts about half-an-hour. Some manufacturers prefer to lay the printed hank upon a bed of sawdust or seeds in trays instead of string, which method obviates any tendency of the colours to drop from the hank in the upper tiers upon the hanks on the lower.

Washing, Drying and Winding.

After steaming, the hanks are placed upon a hooked piece of metal which is fixed to the end of a suspended beam, driven by a crank. This beam swings to and fro immediately over a tank containing a constant supply of clean water with the hanks immersed in it. This process cleanses the worsted of all superfluous matter, after which it is packed in an Hydro Extractor which revolves at 2000 revolutions per minute and partially dries the worsted, the drying process being completed in a suitable stove or chamber heated by steam. The next process is to wind each hank on double headed bobbins ready for the 'setters.' The hank number is affixed to each bobbin so that the setter will know to which part of the design it belongs.

Setting and Beaming.

The object of these combined operations is to arrange the coloured and figured pile threads on the warp beam in such a way that they correctly fit with each other so as to form the pattern that has thus far been sectionally printed on them.

The mechanism designed to accomplish this result is illustrated at Figs. 121 and 122. The former represents a sectional elevation of the bobbin stand, the warp beam and stand including the intermediary parts. The latter represents a plan of the same.

The stand, which is represented at A consists of several tiers of iron plates B with upright pegs on which the double headed bobbins C are placed containing the printed yarn D. The bobbin frame is supported on four strong iron legs E each of which contains

Fig. 122.

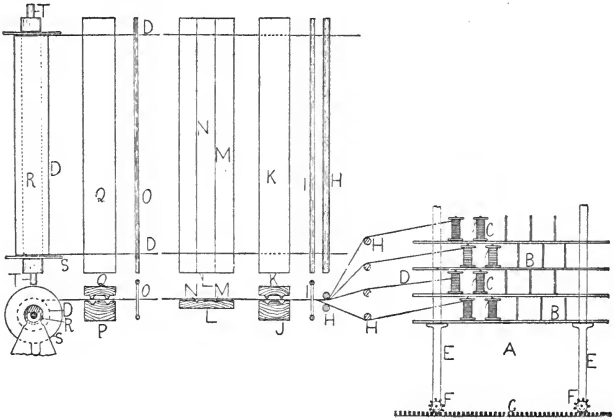


Fig. 121.

a rack pinion F; these fit into a rack G securely fastened to the floor; on this rack, the bobbin stand A, together with its full complement of bobbins and yarn is free to travel to and from the warp beam. The threads D pass from the bobbins under or over guide rods H and through a reed I, then between two clamp boards K and J; the bottom board J has two grooves and the top has an equal number of ribs which just fit into these grooves; the board K is clamped down by means of adjustable screws. The material then passes over L which is a setting board and contains

two grooved lines M and N to facilitate the correct setting of the pattern. The threads are now carried over the length of the frame through the splits of the second reed O (one for each split or dent) between a second clamp P and Q which are respectively similar to J and K, and forward on to a warp beam R, the flanges S of which are set just the width of the warp in the reed; the gudgeon ends T are suitably supported and free to revolve in the bearings of stand U. The guide rollers H, the reed I, the clamp J and K and the setting board L are supported by two brackets one at each end of the bobbin stand.

Process. Each thread having now been carried forward in proper order to the warp beam the clamps P and Q are screwed together and the bobbin stand is moved to its furthest point from the warp beam. The setters then adjust and manipulate the threads across the setting board L to suit the pattern. This, they manage very readily through constant practice, knowledge or familiarity with the design. The guide lines M N materially assist in this operation. The clamps J and K are now screwed togetner whilst those of P and Q are opened. The length of warp thus adjusted is wound on the warp beam by hand, during which operation the bobbin stand A travels along the rack G together with its full complement of bobbins and all parts fixed to it. The operation for each new length is similarly and constantly repeated until the whole of the material has been drawn off the bobbins and the warp beam filled. This work is usually performed by two women setters, though occasionally one woman is sufficient, particularly for narrow "stairs."

The pile warp with the pattern in an elongated form upon it, is now ready to be put into the loom and woven.

The Loom.

A Tapestry loom varies but little from that of an ordinary loom used in weaving plain goods if the wire mechanism be excepted. The width of a Tapestry carpet loom is not confined to 3/4 or 4/4 as is generally the case in Brussels. There are several reed widths used of which the following are typical 3/4, 4/4, 6/4, 7/4, 9/4, 12/4 and 16/4 (sixteen quarters).

All 5/8 stairs and widths of carpet less than 3/4 are woven in the three quarters loom.

Most of the 3/4 looms are driven *direct* on to the crank shaft but compound driving has to be adopted for the broader widths. The method illustrated and explained in connection with Brussels Fig. 38 is an example of the compound plan usually adopted.

The average speed of a three-quarters loom is 86 to 87 picks per minute or 43 to 44 wires as compared with 30 in Brussels.

Shedding. The *shedding* apparatus for ground, stuffer and print warps requires only three heald shafts—

1	Thread	small chain	drawn	through the	second	heald.
1	,,	,,	,,	,,	third	,,
1	,,	stuffer warp	,,	,,	first	,,
1	,,	print	,,	,,	,,	,,

The heald used for print and stuffer contains two eyelets in each mail arranged as shown at Fig. 123 page 198. The stuffer warp is drawn through the lower hole A and the print warp through the upper round hole B. The lower hole A is a long slot and when the heald is down, the stuffer warp rests against the upper portion of it.

A reference to the cross section at Fig. 96 shows that as in Brussels there are two shots of weft to one wire and also two picks of weft in each shed. The healds are controlled by three positive tappets; the two used for the small chain are the same as those illustrated at Fig. 43, page 89; that used for the stuffer and print yarn is similar in construction but it has to lift its heald shaft higher and commence to rise a little in advance of the small chain shaft, but they both complete their traverse at the same time or otherwise the stuffer and print shaft must make its changes in less time. This is to enable the print warp to form a shed for the wire, above the upper division of the small chain. The long hole A through which the stuffer warp passes does not begin to exert any upward movement upon this thread until the print warp has been raised somewhat.

There are four shots to each repeat of *weave* structure.

First pick—single shed:

Lift No. 2 heald with odd threads of small chain and insert first shot of filling.

Second pick—double shed:

Lift No. 3 heald with even threads of small chain and No. 1 heald with stuffer and print warp, insert second shot of filling in the bottom shed and wire in the top shed.

Third pick—single shed:

Heald No. 3 remains up with even threads of small chain; insert the third shot of filling over the print and stuffer warps and odd threads of small chain.

Fourth pick—double shed:

Lift heald No. 2 with odd threads of small chain and heald No. 1 with print and stuffer, insert weft and wire as for the second pick. The above order of shedding is repeated until the required length of carpet has been woven.

Picking from Low and Crank Shafts.

The most satisfactory method adopted is from the low shaft as shown at Figs. 49 and 50 and described on pages 102 and 103, but whenever the switch or trough wire motion is applied it is usual to pick from the crank shaft. One of the chief advantages in picking from this shaft is the possibility of getting a sharper pick. The arrangement consists of two tappets one at either side of the loom; each tappet contains one picking nose, which is set parallel, one with the other. The shaft D Figs. 49 and 50, page 103, which contains the picking tongue C is modified and inclined at an angle of 45° downwards towards the base of the picking stick H; the bent lever F on shaft D is shaped so as to combine and correctly move the picking stick H parallel with the shuttle box. The picking tappets are free to strike simultaneously against a picking tongue on the cross shaft to which each respective picking stick is attached as in Fig. 77 page 132; but the picking tongues are alternately moved into and out of striking range of the tappet noses, consequently the pick is delivered from alternate sides of the loom as is necessary.

Wire Motions.

The chief feature about a Tapestry carpet loom is the wire motion. The speed of these looms being greater than Brussels and

Wiltons, (since there is no jacquard machine) a wire motion must be used which will permit of a greater speed than the wire principle previously described. There are numerous wire motions in use, the Moxon principle being largely adopted in this class of weaving. There are two varieties of this arrangement, viz:—the "switch" and "trough." For wide looms the Dobcross "rope and pulley" wire motion is specially adapted.

Switch.

The essential features of the switch wire mechanism are set forth in the following diagrammatic illustrations.

Fig. 124 represents a plan of the switch with the table on which it works and also of the wire box.

Fig. 125 shows a longitudinal section through the switch and table.

Fig. 126 is a transverse section through the switch, table and wire box.

Fig. 127 shows an end elevation of the tappet and lever connection for producing the reciprocating movement of the wire box and wire.

Fig. 128 is a view of the same as seen from the front of the loom.

The switch is adjusted on a fixed iron table, placed off the right hand side of the carpet and partly in front of the shuttle box, remote from the driving end of the loom. The switch is represented at A and the table at B. The top of the table is planed out or recessed to the same shape as the switch but slightly larger to allow sufficient room for the latter to move freely in a horizontal direction along it.

A square iron block C is pivoted fast into the table at the broad end of the switch as shown in the longitudinal section. A section of this block is cut away from the under side of one end and a corresponding section is planed from the upper side of the switch. The block rests over the switch at this place as illustrated and thereby tends to prevent the switch from lifting on the table.

A screw D is passed upwards through the table and into the hole cut out of the switch at E; this hole regulates and prevents the switch from moving too far.

The small spaces between the switch and the recessed sides of

the table serve as guides for controlling the wire during its insertion into the pile shed or its withdrawal; F represents the guide lines for the insertion and G those of its withdrawal.

Two holes H and H^1 are cut out of the table immediately underneath the switch A; near these holes are two studs I and I^1 fixed into the table and projecting downwards; two stud pins J and J^1 are fixed into the switch also downwards and through the holes H and H^1. Two flat springs K and K^1 are coiled round the respective studs I and I^1 and then passed through narrow slits L and

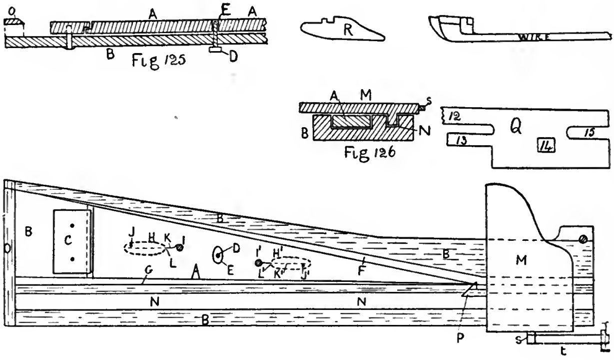


Fig. 124.

L^1 which represent their points of elasticity; the free ends of springs K and K^1 constantly press against the stud pins J and J^1 in the switch; the former tends to keep the terminal end of the guide F and the latter the terminal end of the guide G in close contact with its respective recessed side of the table. But at the same time the opposite ends of the guides are open where the wire enters and along which it travels during insertion or withdrawal.

The wire is inserted and withdrawn by means of a hook box M which is free to slide along and over the switch and table. A 'die' is cut in the table at N and a projection on the underside of the hook

box fits into this die and is free to slide along it and so the correct position of the hook box is maintained.

At the end of the table near the carpet, a thin steel plate O is fixed which limits the distance of the traverse of the wire. The wire head is shaped to fit this plate, and as the carpet is being woven and taken up, the wires are gradually carried along it from the back to the front of the table into line directly opposite the guide line G and hook P which pulls the wire out of the carpet.

The shape of the wire head is shown at Q, the blade at R, the body of the wire at 12 and a projection at 13 forms a space between it and the blade; this is the space into which the thin plate O just

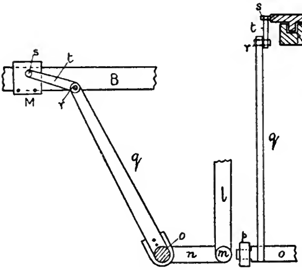


Fig. 128.

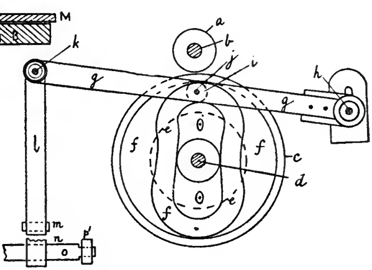


Fig. 127.

fits; the hole 14 in the head is so made that the hook P can fit into it when it is necessary to withdraw the wire.

The wire blade may be compounded and formed at the end of the wire or it can be made separately and attached to or detached from it when required to be sharpened or replaced by a new blade. In the illustration the blade R is shown detached.

A portion of the end of the wire head is removed as at 15 and into this space the front of the wire box fits and is thereby free to move the wire forward into the pile shed as required.

The wire box travels to and fro along the table once every two picks; the front of the box fits into the recess 15 of the wire head and thereby pushes it forward along the guide F. This arrangement

permits the wire head to slide across the hook box M, simultaneously with the traverse of the latter up the table, with the wire in the inclined guide F. The free end of the wire is caught and supported by a suspended lever which moves backwards and forwards in sympathy with the insertion and withdrawal of the wire on exactly the same principle as lever 20 in Fig. 38, page 104. With the forward movement of the wire box the inclined side of the hook presses forward against the wire heads until the shoulder of the hook P has passed beyond the hole 14; then as the wire box returns the hook just fits into the hole 14 of the first wire head and therefore pulls it out of the carpet along the guide G.

Driving of the Wire Box.

The reciprocating movement of the wire is acquired as follows. Figs. 127 and 128:—

A small pinion *a* is keyed on the crank shaft *b* at the opposite end from the driving pulleys; this pinion wheel gears into a spur wheel *c* four times its size; the wheel *c* is fixed to the low shaft *d* which therefore makes one revolution to four of the crank shaft *b*. The shedding tappets, not shown in this illustration are secured through the wheel *c* to the shaft *d*. Near the end of this shaft a disc plate *e* is secured: placed on the same shaft and secured to the plate *e* is a large positive tappet *f*, which can be adjusted to suit the timing of the insertion and withdrawal of the wires.

A treadle lever *g* is fulcrumed to the stud *h*; an antifriction bowl *i* is free to revolve upon the fixed stud *j* in lever *g*.

The bowl *i* works between the inner and outer cover rings of the tappet *f*; the free end of the lever *g* is connected by a loose stud *k* to an upright connecting and lifting rod *l*; the lower end of this rod is joined by a second loose stud *m* (at right angles to that of *k*) to a short lever *n*; without these loose studs it would be very difficult to lift the shaft *n* at right angles to that of treadle lever *g*. The short lever *n* is fixed to a short shaft o which is supported in suitable bearings *p* and p^1; to the shaft *o* an upright lever is secured as illustrated and its upper arm is joined by a loose stud *r* to a short connecting rod *t*; through the opposite end of this rod a stud *s* passes into the side of the wire box M.

Action of the Mechanism.

With the constant revolution of the low shaft the tappet *f* operates upon antifriction bowl *i* so as to lift the treadle lever *g*; the last through stud *k* rod *l* and stud *m* elevates the lever *n* which thus turns shaft *o* counter clockwise (Fig. 128) and so the lever *q* through its connections described, pushes forward the wire box M, which being in close contact with the wire carries it forward up the guide F into the pile shed. (Fig. 124).

The reverse motion is obtained by the depressing action of the tappet on the treadle lever *g*. It will be observed from the shape of the tappet that it elevates and depresses the treadle lever *g* twice to each revolution *i.e.* once for every two picks of weft as required by the weave structure of the carpet.

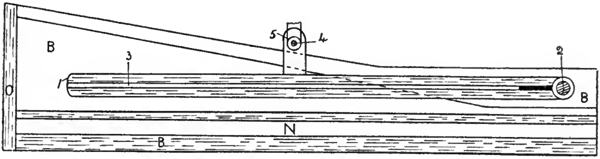


Fig. 129.

It might be pointed out here that application of power to the wire mechanism has to be transmitted from the driving pulleys, through the crank shaft to the opposite end of the loom and then through pinion wheel *a* spur wheel *c* and all the described mechanism illustrated at Figs. 127 and 128, before it reaches the wire box which it will be observed is a long distance from the initial power of application.

Trough Wire Motion.

The parts of mechanism which are necessary to illustrate this principle are sketched at Fig. 129 which represents a plan of the table and trough—the trough in this motion replaces the switch A in Fig. 124. A lever 1 is fulcrumed to a stud 2 fixed into the table; a groove 3 is formed in the lever 1 of sufficient width to permit the traverse of the wire head along its passage; near the centre of lever 1 an

upright stud 4 is fixed; this stud is joined by a connecting rod 5, Fig. 130, and a swivel 6 (for regulating the length of the rod 5) to a vertical lever 7 which is fulcrumed at 8. A specially constructed tappet 9, secured to the low shaft, operates upon an antifriction bowl 10 in the lever 7 as represented at Fig. 130. A strong spiral spring 11 connects the lever 7 with the loom supports and thereby keeps the antifriction bowl 10 in constant contact with the tappet 9. With the revolution of the low shaft, the tappet 9 operates upon the bowl 10 and thus reciprocates the lever 7, which, through the connecting rod 5 and stud 4, produces the horizontal sliding motion in the trough lever 1 about the stud 2. The cam is timed to place the lever 1 in position to receive the wire as it is drawn out of the carpet and then to move the lever with the wire to the remote side of the table in position ready for insertion into the pile shed. The foregoing represents the chief feature of difference from the switch arrangement—in every other detail the mechanism is coincident.

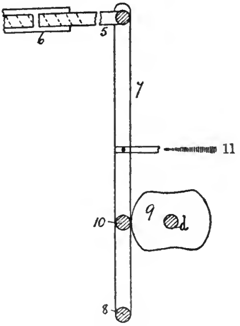


Fig. 130.

Beating up. Beating up the weft and wires into the carpet is on the single beat principle direct from the crank shaft.

Warp Controlling Mechanisms.

There are three warp beams to control when letting-off, viz:—the small chain, stuffer and print warps.

Small Chain and Stuffer. These warps are sometimes regulated by positive warp controlling mechanisms. The Jumbo system as at Figs. 54 and 55 is in some instances used and a negative arrangement is also applied to the stuffer warp beam. The following *negative* method which is applied separately to both warp beams possesses many points which merit consideration.

A vertical section showing the essential features is supplied at Fig. 131. A portion of the framework is shown at 1; the stuffer warp beam 2 is supported in two brackets one of which is shown at 3; to a fixed stud 4 one end of a chain 5 is secured which is then coiled once round a pulley at the end of the warp beam 2 and hooked to an adjustable bolt 6 which passes through the lever arm 7 compounded with a sleeve 8 and a second lever 9; the sleeve is supported and free to turn about an adjustable stay rod 10 which is supported to both ends of the loom frame. A loose roller shaft 11 stretches across the loom and rests upon the arm of lever 9 and its duplicate on the opposite side of the loom; to each end of this roller shaft a half moon lever is secured, one of which is shown at 12; from this lever a chain 13 is suspended and fastened to a lever 14 which is fulcrumed to the loom supports by a stud 15, and a heavy adjustable weight 16 is placed on it; the warp 17 from the beam 2 is now passed behind the stay rod 10, in front and over the roller shaft 11 and forward to the healds.

Action of the Mechanism.

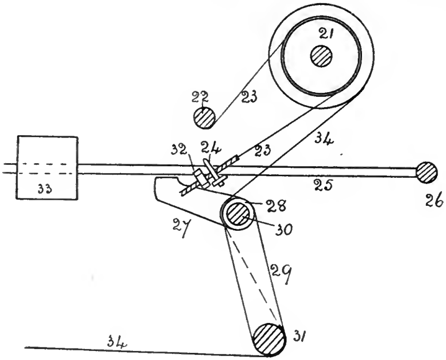
Immediately the healds pass the centre, the warp tightens—particularly the bottom shed, which therefore exerts pressure on the roller shaft 11 and tends to pull it towards the healds; the lever arm 7 then recedes slightly and thereby releases the tension in the chain 5; the beam 2 is consequently free to let off a small length of warp 17; the weight 16, operating by its own gravity upon the lever and through chain 13 upon the half moon lever 12, prevents any undue forward movement of the roller shaft 11 and also brings it back to its normal position as the pressure upon the warp by the healds is released.

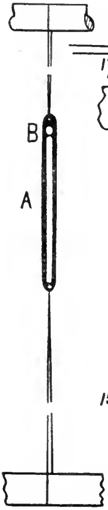
A duplicate set of mechanism controls the warp beam with the small chain; the numbers 1^1 to 17^1 refer to corresponding parts. When the going part is exerting its pressure against the fell of the carpet the warp roller 11 is firmly gripped by a brake appliance similar in principle to that illustrated from 24 to 29 Fig. 54, page 112.

Tension on the Print Warp.

The system of regulating the print warp is illustrated at Fig. 132 which shows a vertical section through the essential parts of the mechanism. This arrangement is negative in its action.

Fig. 132.





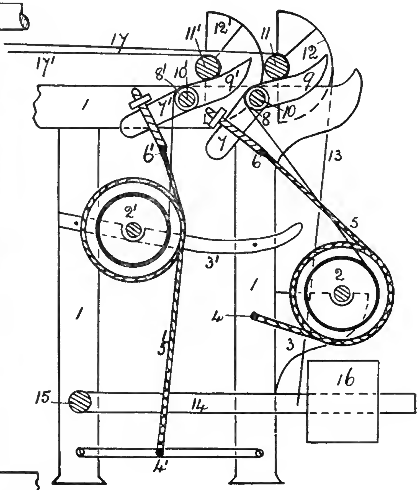


Fig. 123.

Fig. 131.

The warp beam is represented at 21 and a stud 22 is fastened to the loom supports; to this stud one end of a thin iron band 23 is made secure and then the free end is coiled one and a half times around a pulley fixed to the end of beam 21 and terminates in the form of a bolt which is threaded and passed through an 'eye' bolt 24; this eye bolt is fastened to an iron plate lever 25 called the letting off lever which is centred and free to move about the fixed stud 26. The lever 25 rests upon the free end of a lever 27 compounded with a sleeve 28 and a swing lever 29; the sleeve 28 is on and free to turn about the shaft 30 which passes across the back of the loom and is fixed to the frame supports. The swing lever 29 supports the swing shaft 31. The tension of the iron band 23 on the warp beam 21 is regulated by adjusting the nut 32, behind the eye bolt 24. A weight 33 is placed on the lever 25 and can be adjusted to increase or decrease the pressure on the iron band 23 at will. The print warp 34 is passed from the warp beam to and behind the fixed shaft 30, then over and in front of the swing shaft 31 and forward to the healds.

Action of the Mechanism.

Immediately the healds pass the centre, the warp tightens and with it, pressure upon the swing shaft 31 increases, thus causing it to move inwards to the left and in sympathy with sleeve 28, and so to elevate the lever 27 which in turn operates upon and elevates the letting-off lever 25; by this means the pressure on the ends of the warp beam 21 of the iron band 23 is somewhat relaxed, while the tension on the warp causes the warp beam to turn slightly and so give off some of its warp. The weight 33 prevents any undue elevation of the letting-off lever and also increases the tension of the iron band 23 when the healds are passing each other and the lay of the going part is just beating the weft and wire into the carpet.

Taking up—Positive.

The method of taking up the carpet is positive being similar in principle to Figs. 61 and 62 page 117, but the motive power is derived direct from the crank shaft instead of from the bottom shaft, as in the foregoing illustrations.

Designing and Colouring.

The designs are first sketched, then coloured on specially ruled paper of sizes which accord with the required pitch, fineness or number of points in the carpet on exactly the same principle as for Brussels or Wilton. The length of pattern is determined by the circumference and scroll capacity of the drum, together with the number of loops per inch required in the carpet *e.g.* If the capacity of the drum be 1072 scrolls and the pitch of the carpet required is eight points per inch, then the greatest length of pattern which can be printed on this drum is represented by dividing the number of points per inch in the carpet into the scroll capacity of the drum, thus:—

$$\frac{\text{Scroll capacity of the drum}}{\text{No. of points per inch in carpet}} = \text{Length of pattern.}$$

$$\frac{1072}{8} = 134 \text{ inches} = 3\tfrac{3}{4} \text{ yds.}$$

And with 7 points per inch the length of pattern would be equal to

$$\frac{1072}{7} = 153 \text{ inches} = 4\tfrac{1}{4} \text{ yards.}$$

Any pattern whose number of wires in one repeat is a measure of the scroll capacity of the drum can be made and subsequently printed upon it thus:—$\frac{1}{2}$, $\frac{1}{4}$ and $\frac{1}{8}$ of any of the foregoing patterns would contain 536, 268 and 134 wires in each repeat of pattern respectively. The same facts relate to other drums of different capacities.

In respect to the width of pattern there is, like colour, absolutely no limit, but it is advisable to keep the number of threads as well as colours within reasonable dimensions.

The outline of each colour in a Tapestry carpet is not well defined since the edges of the colours run, more or less, into each other in the carpet, due to printing of the pattern on the yarn before weaving. Even though each section of the pattern has a tendency to associate with its adjoining colour, gradation cannot be successfully and methodically attempted; it is therefore better to keep each section of pattern and colour distinct on the design paper. The

light colours in Tapestries suffer considerably in the printing process, because the darker shades run into them most readily and so reduce their tone. In order to neutralise this tendency it is essential that the lighter colours should occupy a relatively greater area on the design paper *e.g.* three 'cords' of white or two cords of yellow, to one cord of black, dark blue, green or brown are estimated to produce a satisfactory stripe, because when these are woven their contrasts are considerably reduced.

Through lack of knowledge on this point many otherwise good designs are rendered worthless and the designers completely fail.

Greater skill is required for drafting and colouring this class of designs than for any other on account of the tendency of the colours to bleed and because of the great heat (above boiling) to which the coloured yarns are subjected during the steaming process, which severely tests the fastness of the colouring material and tends to change the hues.

Another fact which must be considered is the shrinkage of the print yarn during steaming which must be regained in the weaving.

Usually the weaver is supplied with a 'match' stick, which he uses constantly throughout the length of the warp to ensure the production of a uniform length of pattern on the whole of the carpet. Various registering and tensioning devices have been attempted for regulating the warp and causing the pattern to run evenly.

Velvet Pile Tapestries.

The pattern for cut or Velvet Tapestries sometimes called "Axminster Tapestry" is printed in exactly the same way as for the ordinary or looped pile structures already described.

The structure of the foundation fabric and method of binding the tufts of velvet should bear the same relation to the corded or looped pile as Wilton does to Brussels *i.e.* there should be *three* shots of filling weft to each wire in the velvet, as compared with *two* in the corded carpet. But this important condition is not always adhered to. Figs. 136, 137 and 138 are illustrations of both velvet structures; the first represents a 'two shot,' the second and third are each 'three shots.' In Fig. 137 the tufts are wrapped about *two* weft

threads but in Fig. 138 they are wrapped about *one* thread of weft only. In each diagram the small chain, stuffer and pile warps and filling weft are represented at A B C D respectively.

Sometimes velvet pile Tapestries are made in 'double pile' looms. These looms are capable of weaving two carpets together face to face, in the production of which they usually require two

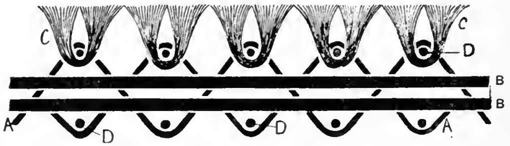


Fig 136.

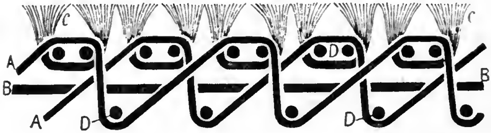


Fig. 137.

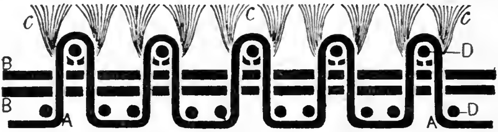


Fig. 138.

ground and stuffer warps and *one* pile or print warp which interweaves with the warps and wefts of both the upper and lower carpet bases.

The pile lies evenly between the two carpets and is automatically cut in the loom by a knife which travels across and between them *once* for every two shots of filling.

The preparation of the pile yarn together with the method of printing the pattern upon it, is identical with the principles described and illustrated in the preceding pages, except that a scroll pulley of *double width* is used in order to print the pattern wide enough to suit the *double* length of pile necessarily required.

Squares and Rugs.

Whenever the pattern has been printed on the warp threads, whether singly or collectively, the side borders and corners in Tapestry carpets may be woven from the same printed warp by simply turning one of the warp beams round. With this arrangement both sides of the carpet are woven in the same direction, which is a considerable advantage, especially if the loops are cut and a velvet Tapestry square is required since the fur all lies in the same direction. There is a further advantage in being able to produce a smaller number of carpets at the same ratio of expense as obtains in the production of the larger quantity and which also avoids the necessity of making a larger number of carpets than is sometimes necessary.

Printing the Pattern on the Woven Carpet.

Prior to the actual printing process, the carpet is prepared by a special damping solution. It is then dried rapidly by running it over hot cylinders, after which it is ready for the application of the colouring material.

There are several devices for stamping the pattern in different colours upon the carpet after it has been woven. The following diagrammatic illustrations are sufficient to demonstrate the general principles of this process, which is applicable to either the ordinary loop or velvet pile.

Fig. 133 is a vertical section of the printing machine.

Fig. 134 is a section of the engraved printing drum.

Fig. 135 shows a similar section when charged with colouring material.

The chief parts of the mechanism may be described as follows:—

A represents a large pressure drum, which is free to revolve in suitable bearings. The carpet B revolves with this drum—loops

outwards; C represents the engraved printing roller which is free to rotate, with several tons perpendicular pressure contact, against the face of the carpet; a colour feeding roller D rotates in the colour of colour box E and also against the pattern printing roller C and thereby keeps it constantly supplied with colour.

Fig. 133.

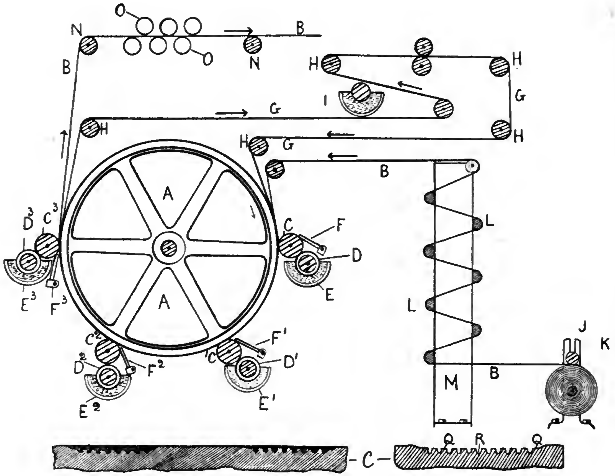


Fig. 135. Fig. 134.

A lever scraping device is shown at F; it is arranged to bear upon and scrape the surface of the printing roller C by which means all the superfluous colour is removed. An endless thick blanket G is interposed between the carpet and the surface of the pressure drum A and around the roller guides H. A washing device as arranged at I constantly cleanses the blanket from any colouring substances which it has acquired during its journey between the drum A and pressure of the colour printing roller C, through the

carpet B. This blanket tends to equalise the pressure between the drum A and printing roller C upon the carpet.

Duplicates of parts C D E and F are shown at C^1 to F^1, C^2 to F^2 and C^3 to F^3, for printing additional colours.

The carpet B is placed in a stand J and a roller shaft K rests upon it; a series of tension bars are shown at L over which the carpet passes and is regulated as it travels forward to the printing operation as seen in stand M.

After the carpet leaves the last printing roller, steam is freely blown through the face and back of it from perforated steam pipes as at O, which are about one inch apart and close to the carpet on either side. The object of steaming is to fasten the colours which have just been printed on the pile yarn. The carpet is next passed over the guide rollers N and then run over hot cylinders until about half dry and completed in a steam chamber, where they are exposed for about one hour.

The back of the carpet is stiffened by running it over a brush which revolves in a mixture of starch and glue, either before or after printing.

The pattern rollers C are made of copper and there is one cylinder required for each colour.

The section of the design for any particular colour is marked out by the engraver on the surface of the copper cylinder and first cut out to a depth of about one-sixteenth of an inch and preferably bevelled at the edges of the figure; deeper cuts are afterwards made in the form of cells of a total depth of about one thirty-second of an inch and from $\frac{1}{32}$ to $\frac{1}{16}$ of an inch in diameter and about $\frac{1}{16}$ of an inch apart. The edges of the cells are also bevelled. These cells or cups are designed to hold the colouring matter, into which the pile loops are subsequently pressed. Sections of this printing roller are shown at Figs. 134 and 135; the engraving Q is sunk below the surface and holes R below the engraving are made for the purpose of holding the colour as seen in the latter figure.

CHAPTER VII.

Axminster Carpets.

Axminsters belong to the richest and costliest of *machine* made carpets. They were originally made at Axminster in Devonshire early in the latter half of the eighteenth century on hand looms and afterwards at Wilton in Wiltshire, but now they are produced almost exclusively on power looms in many parts of this and other countries, Halifax and Kidderminster in England being notable centres; the names given to the various carpets, which formerly indicated the locality where they were made, now only serve as marks of identification. The Axminster power loom is an American invention; it was introduced into England in the year 1878 and gave a tremendous impetus to the carpet industry of this country.

The above carpets belong to the *tufted* or *velvet* pile class, and are unlimited and unfettered in variety of design and colour, being usually made from superior qualities of figuring material, which thus permits the display of bright and cheerful colour schemes. Ordinarily they are woven without the aid of a jacquard machine; all the pile material is lofty, being cut to a considerable length and woven closely—comparatively. Each tuft is utilised for figuring and is displayed on the surface as a definite and distinct colour; there is no pile material stowed away in the body of the fabric; usually a standard grade Axminster contains from 50 to 60 points per *square inch*. The figured design is produced by the combination of these differently coloured tufts in masses great or small to suit the requirements of the pattern. These are the factors which make such carpets approach nearer in structure and appearance to the *original hand made carpets*. Generally speaking they are far superior to those of eastern and hand made productions and where the price is permitted to enter as a factor they leave these primitive structures still further in the rear. There are numerous varieties of Axminster, but these may be divided into two chief classes:—

(1) Royal and Crompton Axminsters—Moquette;

(2) Chenille or Patent Axminster.

These will be treated separately and in different chapters after the original hand made carpets have been briefly described.

Hand Made Carpets.

Hand made carpets which are the original or real carpets are made with 12 to 16 tufts of pile per square inch for the coarser kinds and from 100 to 400 in the finer sorts.

The original hand made carpets of the East were made in two ways:—

First: The foundation structure was woven without any fur, a sufficient space being left between the threads for the subsequent interlacing of the pile. Each tuft was separately locked about the warp or weft threads of the foundation cloth by hand, which system permitted the employment of colours without limitation. An illustration of such a method is supplied at Fig. 139. Sometimes

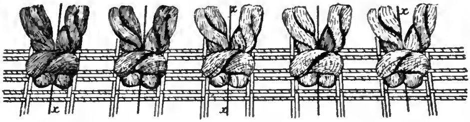


Fig. 139.

fine but strong binding threads x were stitched alternately over and under each pair of transverse weft threads but care was taken to make each binding thread pass under the base of its respective tuft. This additional binding thread added considerably to the wearing qualities of the finished carpet.

Second: The pile and foundation structure were produced together during the process of weaving by hand as illustrated at Fig. 140. The loom if such it might be called was very rudely constructed. It consisted of two upright posts AA near the tops of which the warp roll B containing the warp threads C was placed and free to revolve. Tension was applied to the warp roll from a rope which

was fastened to the frame posts then coiled round the warp beam and had suspended at its free end a dead weight. The filling weft is indicated at D, the fur at E and the carpet at F which may be of any desired pattern, number and combination of colours. The weaver was provided with the pattern sketched and coloured to the

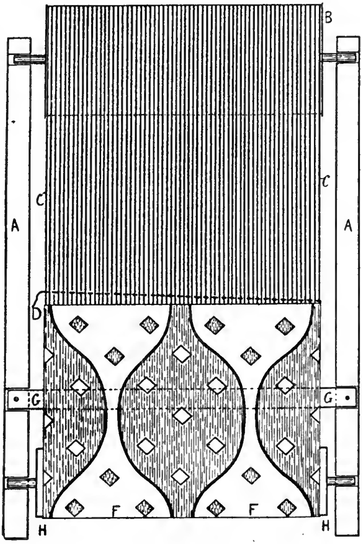


Fig. 140.

actual size of the required woven carpet together with as many coloured threads as the point paper design contained.

The woven carpet was supported by passing it over a straight and smooth bar of wood G to the piece roll H. The structure of the foundation texture was the usual 'canvas' or 'plain' method of interlacing, each individual tuft being wrapped about the warp

threads in the manner shown at Fig. 141. After a few inches were woven without any fur, to serve as a 'thrum' end and for turning under, one row of tufts was interlocked about its respective pair of warp threads, then one shot of filling was inserted and separately beaten into position with a stick.

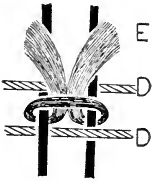


Fig. 141.

Axminster—Moquette.

There are several varieties of Axminster, passing under different names such as Royal, Crompton and Moquette, etc. In each of these there is a slight difference in respect to the base structure, method of binding, and length and fineness of pile, but the fundamental principles of each are the same as regards formation of tufts, possibilities and limitations of design and colour together with their general appearance.

'Moquette' is a French term for its equivalent English 'Axminster' and is largely used to designate these fabrics in the U. S. A.

In these several varieties there may be two or three warps for the base and stuffing and one or two wefts for filling and binding in addition to the fur which is interwoven and displayed on the surface.

The materials used consist of cotton or linen for small chain or binding warp, jute for stuffer warp, float and bottom or back weft, cotton, linen or jute for top and binding weft and worsted yarn of good quality for the fur or tufts.

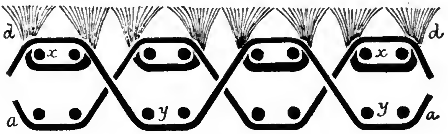


Fig. 142.

A few of these structural varieties are illustrated at Figs. 142 to 146, each of which represents a transverse section through the weft.

Fig. 142 shows two *double* shots of weft to each row of tufts.

a. is the small chain composed of 2/14 linen.

d. is the tufting material, which is made of good quality and is equal to 2/3 worsted.

x. is the top or binding weft; it is a two-fold jute yarn and contains 18-lbs per spindle (Aberdeen).

y. is the bottom filling; it is a thick black worsted of low Indian wool and loosely spun to about 2/3½ counts; it answers the purpose of imparting a soft and full back to the carpet.

The length of the pile is about $\frac{1}{3}$ of an inch above the base structure which requires about $\frac{7}{8}$ of an inch of tufting yarn. The number of tufts per square inch is 7 × 7 and 60 yards of ground chain A will produce approximately 40 yards of carpet.

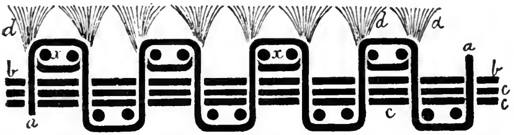


Fig. 143.

Fig. 143 represents a transverse section through the weft of another structure. In this fabric there are two chain warps—one long and the other short and also the addition of two stuffer warp threads.

a. indicates the *long* chain which passes over the binding weft and through to the back and under the backing weft. It is composed of 4s linen good quality.

b. is the *short* chain and lies straight between the top pair of picks and immediately above the stuffer warp; it is composed of 3/16 white cotton.

c. shows the position of the stuffer warps which consist of 3/9 fawn coloured cotton.

d. is the tufting material and is made from a good quality of wool spun to 2/3 worsted counts.

x. is the filling weft composed of two-fold jute yarn containing 15lbs. per spindle (Aberdeen counts).

The order of warping is as follows:—

1 thread long chain for binding.
1 " short " " float.
1 " stuffer warp.
1 " stuffer warp.

All in one split and containing 7 splits or dents per inch.

Weft:—One double shot for top or binding pick and one double shot for bottom or back pick—14 double picks per inch.

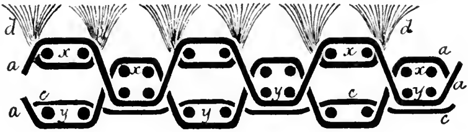


Fig. 144.

Fig. 144 shows also a transverse section through the weft.

a is the small chain and binding warp and is composed of cotton.
c is a jute stuffer warp.
d is the tuft or fur yarn.
x is the top or fur binding weft.
y is the bottom or back filling weft.

In this example there are four double shots of weft to each row of tufts.

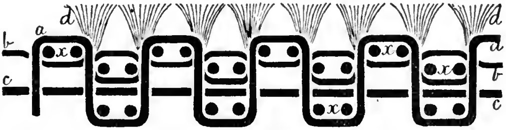


Fig. 145.

Fig. 145 is a transverse section of a Crompton Axminster and contains three double shots of filling to each row of tufts.

There are three warps in addition to the fur.

a. is the long chain which binds the structure together and is 2/2/16 cotton—good quality.

b. is a tuft support warp 2/14 linen.

c. is a float, straight or warp thread also 2/14 linen.

d. is the fur chain.

x. is the binding and filling weft, which is made of 6s linen.

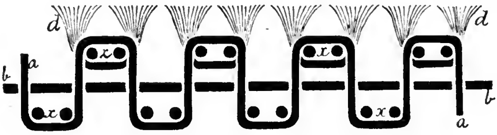


Fig. 146.

Fig. 146, shows a cross section through the weft of a structure which contains two double shots of weft to each row of tufts and one long binding chain warp with one float or straight warp.

a. represents the long chain—cotton.

b. ,, ,, straight warp—linen.

d. ,, ,, fur—worsted.

x. ,, ,, filling weft—jute.

The Axminster Loom.

The weaving mechanisms used for the manufacture of Axminster Carpets and Moquettes which correspond in structure to the examples supplied from Fig. 142 to 146, agree in their fundamental principles. There are unimportant differences of details which apply to the production of the respective base structures and also various methods of clothing the same mechanical principles. The formation of the pile constitutes the chief feature of the loom mechanisms.

A perspective view of an Axminster loom is shown (minus the chains and tufting carriage) at Fig. 147. This permits a full view of

the tappet or cam shaft 22, as seen from the back of the loom. This shaft is the most important piece of mechanism in the loom since from it nearly all the varied and compound motions are

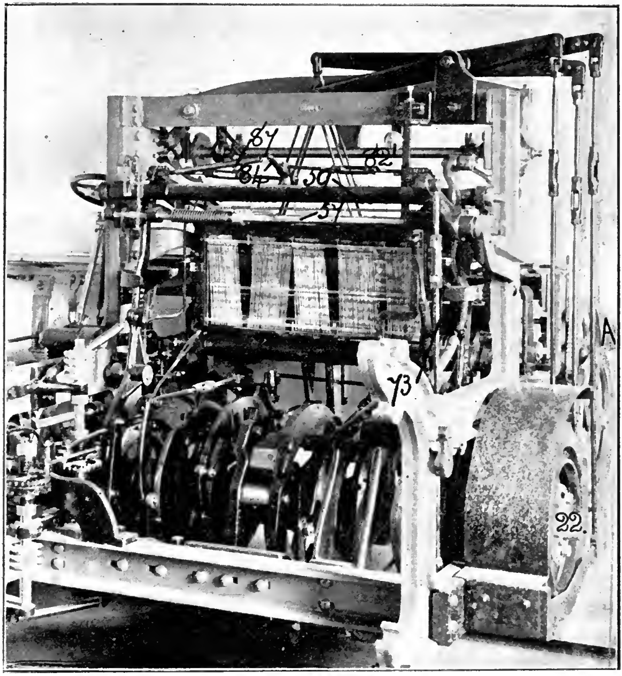


Fig. 147.

obtained. The numbers on this illustration refer to similar parts described in connection with Figs. 159 and 160.

It is proposed to describe the Axminster Carpet Loom and the manufacture of such carpets in the following natural order.

1. Driving mechanism.
2. Shedding of the warps—foundation structure.
3. Tufting mechanism and formation of tufts.
4. Picking—positive.
5. Beating up the wefts and tufts.
6. Taking up the carpet.
7. Warp controlling motions.
8. Incidentals.

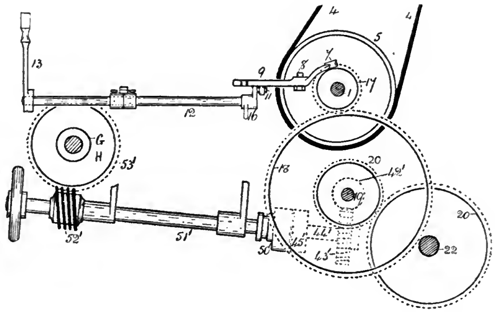


Fig. 148.

Driving—Frictional.

In an Axminster power loom there is a considerable number of variable and intermittent motions, which consequently necessitate greater power at some stages of its work than at others; with the ordinary system of driving, such variation causes the loom to be constantly 'knocking-off' and in addition it is difficult to start it again in a position where considerable force is necessary. The object of the frictional and compound driving is to enable the loom to negotiate any of the foregoing difficult places and also to be started in any position and stopped instantly.

Illustrations of one method employed are supplied at Figs. 148 and 149; the former is an end view and the latter a plan.

A short stout shaft 1 is supported between the loom frame 2 on one side and a supplementary frame end 3 at the other; a belt 4 from the mill shafting is free to communicate motion to a movable *friction* pulley 5 which is loose on shaft 1. A second pulley 6

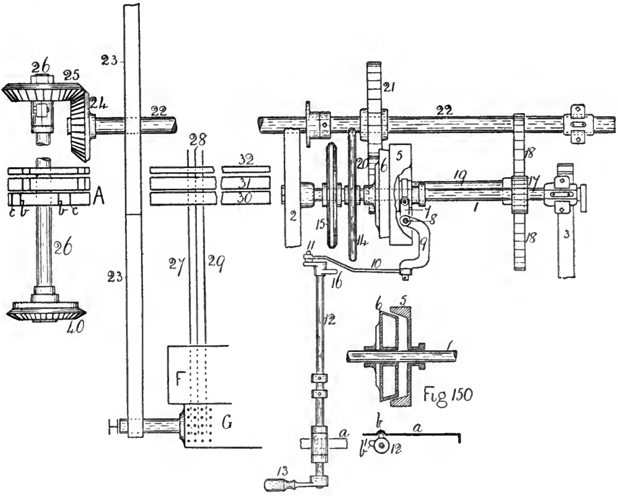


Fig. 152. Fig. 149. Fig. 151.

of cone shape and covered with leather to increase its gripping properties is securely fastened to the same shaft. These two pulleys may be brought together and held in close contact upon each other, without exercising any undue strain upon any other parts of the loom. A vertical section through the shaft 1 and the frictional pulleys 5 and 6 is illustrated at Fig. 150. A portion of the frictional pulley 5 has been removed to show the arrangement

for engaging or disengaging it with pulley 6. A forked lever 7 fits into the grooved collar of pulley 5 and is free to move the latter in a lateral direction along the shaft. A stud 8 supports and serves as a centre for lever 7 together with the bent lever 9; a link 10 connects the arm 9 with bracket lever 11 on shaft 12 which is supported on the loom framing and free to move on its own axis. A hand lever 13 is fixed to the square end of shaft 12; a quarter of a revolution of this lever is sufficient to bring the pulleys 5 and 6 into firm contact and conversly to release the engagement of same. The shaft 12 is held firmly in either position by means of a flat spring *a* which engages suitable projections *b* or b^1 on shaft 12 Fig. 151. On the shaft 1 a smooth balance wheel 14 is secured with which to turn the loom slightly by hand; adjoining this is a brake wheel of usual construction and operated on at its periphery by a brake which is connected to the arm 16 on shaft 12 in such a manner that when the shaft 12 is turned the brake is applied simultaneously with the disengagement of the friction pulleys and the loom instantly stopped. Similarly the brake is released when the friction pulleys are brought into close contact.

Driving the Main or Cam Shaft and Shedding Tappets.

A pinion wheel 17 is secured to the shaft 1 and gears into a large spur wheel 18 on shaft 19 which is supported between the frames 2 and 3; on this shaft, to the left of pulley 6, a pinion wheel 20 in turn engages a large spur wheel 21 securely fastened to the shaft 22. This shaft carries the cams, which operate the tufting mechanism, lay of going part and picking, for which reasons it has probably derived its name 'The Cam Shaft;' it extends across the full width of the loom being further supported in the loom framing 23 and carries at its opposite end a small bevel wheel 24 which in turn gears into a similar bevel wheel 25 on a shaft 26 parallel with the loom end. This shaft supports and rotates a series of cams which operate through connections, described later, in such a way as to cause the healds to be moved positively and *evenly at both* ends, whether they are being *elevated* or *depressed*. In some cases the shedding tappets are operated directly from the cam shaft 22, the illustration at Fig. 147 is an example to wit.

Shedding—Small Chain and Stuffer.

The ordinary shedding apparatus is illustrated at Figs. 152 and 153. The former shows a plan and the latter a front elevation. There are two warps 27 and 28 used for ground chain and one stuffer 29; each warp is wound on to a beam and placed into position as shown in Fig. 171. These warps respectively pass through the mails of heald shafts 30, 31 and 32, to the carpet

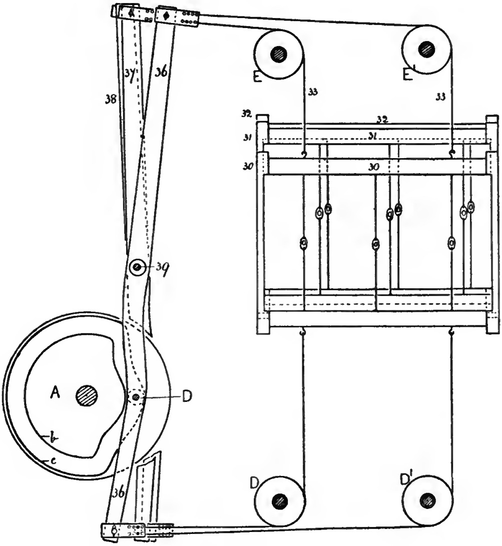


Fig. 153.

which passes over the smooth plate F, to the spiked roller G in the taking-up shaft H Fig. 152.

The heddles are suspended by cords 33, 34 and 35 which freely pass over pulleys E, E[1] and under pulleys D, D[1] supported to the loom framing after the manner shown. These cords connect the heddles

to three vertical treadle levers 36, 37 and 38 centrally fixed and free to move about the stud 39. The lower ends of these treadles are similarly connected to the underside of the heald shafts. Three tappets constructed on the positive principle respectively operate by rolling contact on the antifriction bowls in levers 36, 37 and 38 placed below the fulcrum 39 in the position shown at Fig. 153. Only one of the shedding tappets is shown as at A; it contains an inner ring or projection *b* and an outer ring or cover *c*; the ring *b* operates on the antifriction bowl D to elevate, through connections already described, the heald shaft, whilst the cover ring *c* pressing on bowl D causes the heald shaft to be depressed. The tappets being constructed to produce the necessary variation and depth of shed are set and timed to correctly elevate and depress the heald shafts in unison with the tufting motion and insertion of the weft.

The heald shafts are sometimes arranged in the following order (1) ground or long chain, (2) stuffer heald and (3) extra heald which carries the straight and short chain.

Tufting Mechanism.

Tufting Frame, Spool and Tubes.

The tufting frame or carriage together with the spool on which the several coloured pile yarns are wound and the tubes through which these yarns pass to the carpet are all jointly illustrated at Fig. 154.

The tufting frame or carriage is made of wood and is indicated at *a*. To this frame the spool is placed and to it the tubes are secured. *b* represents the tufting spool on which the differently coloured pile threads *c* are wound; these threads are shown passing from the spool *b* to and through the fur tubes *d* and to the carpet below.

A long smooth bar *s* is placed over the entrance to the tubes and over this bar the tuft yarns pass thus protected from unnecessary rubbing against the sharp edges of the tubes *d*. The journal upon which the bobbin is free to rotate is shown at *e*. It is supported upon the upright finger *f* which together with a pin *l* and spring *g*

is secured to the frame *a*. The pin *l* is free to pass through the double link *h* in the carrier chains, *i* being the single link. The spring *g* is designed to pass over the inside of this double link, when the pin *l* subsequently enters it, and thereby tends to keep the frame *a*, etc., in the chains until released by the transferring arms, a section of which is shown at 60 and subsequently fully described.

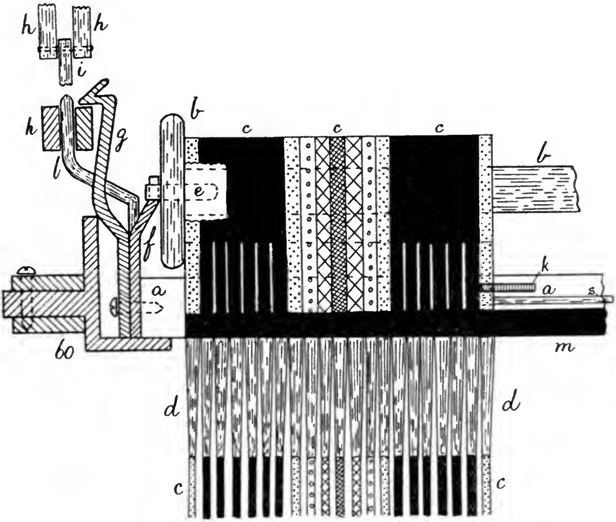


Fig. 154.

The tufting tubes *d* are usually made from tin or thin metal; a number of these which coincides with the number of pile yarns in the spool and the required number in the width of the carpet are soldered together at their upper ends to the required fineness and pitch of carpet. The whole of these tubes are then soldered to a thin right-angled piece of tin, which in turn is screwed fast to the

tufting carriage or frame A. Sectional illustrations of these tubes are shown, actual size at Fig. 155. X is a front view of a portion of a tube series, Y an end view of a single tube and Z a plan of the series X; the tubes are shown at *d*, the position of the soldering at

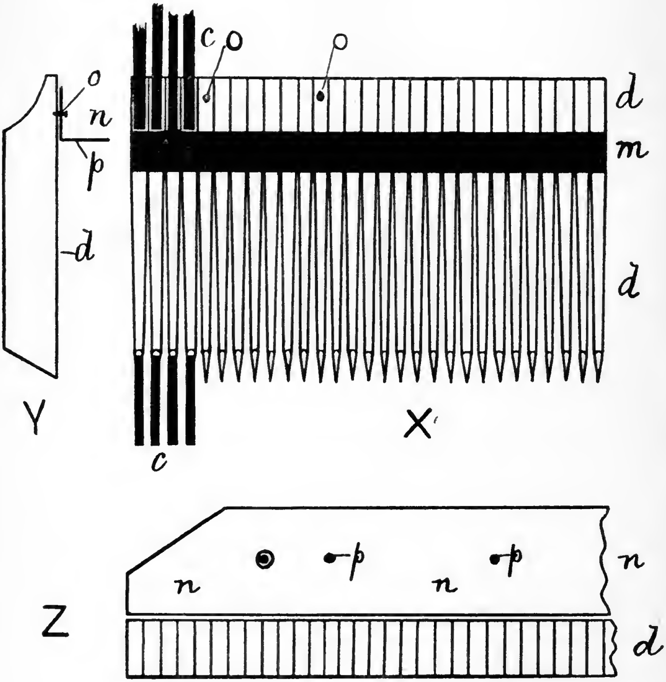


Fig. 155.

m and the thin right-angled piece of tin at *n*; the letters *o* and *p* represent small screws which are passed through the tin *n* and secured into the wooden frame *a*. When the whole of the bobbins have been filled and placed in their respective carriages, they are

ready to be put in proper and respective order in the chains.

Chains.

The two chains for carrying the tufting carriage are each composed of a series of pairs of single and double links pivoted together; to each pair of links there is one tufting carriage. The double links have open bearings with enlarged parts and flanges. Into these open bearings the journals *l* of each respective tufting carriage are placed; the tufting tubes should always be perpendicular with the centre of the chain wheel. The periphery of the chain wheel coincides with the shape of the open bearing of the double link in the chain and thus permits the carriage journal to pass through the links unobstructed.

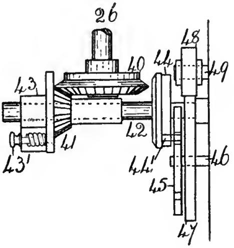


Fig 156.

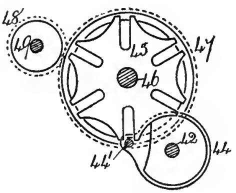


Fig. 157.

The flanges serve the purpose of keeping the journals in their fixed positions in the chain, except when the carriage is required to be moved from them.

Support and Driving of the Chains.

The endless chains with the carriage and its complement are mounted on ratchet or chain driven sprocket wheels contained outside the loom supports. The sprocket wheels receive their intermittent motion by a chain connection with a train of wheels as described below:—

Fig. 156 represents a plan of the train wheels which operate the chains intermittingly.

Fig. 157 illustrates parts of this mechanism.

To the terminal end of shaft 26 (Fig. 152) a bevel wheel 40 is secured; this wheel engages a second bevel 41 half its size and secured to the shaft 42 which is in turn fastened to the loom frame as shown. The bevel 41 is loose on the stud 42 but it can be combined with a clutch device 43 which latter is made fast to the shaft 42. An adjustable pin 43^1 is combined with the clutch 43 and exactly fits into a hole in the bevel 41. Into this hole or socket the pin can be inserted or it may be withdrawn, at will. Secured to the shaft 42 is wheel 44 which contains a projecting pin 44^1. This pin is free to engage a hexagonal star wheel 45 combined with a spur wheel 47 both of which are free to revolve about a shaft 46. The spur wheel 47 combines and drives a pinion wheel 48 on a short shaft 49 supported in suitable bearings of the loom frame. The shaft 46 extends across the loom and carries at its opposite end a duplicate of spur wheel 47, which in turn combines and drives a pinion spur wheel 48^1 on the shaft 49^1—duplicates of 48 and 49 respectively. To each shaft 49 and 49^1 there is a chain wheel which communicates revolving motion to the sprocket chain wheel shaft 51 shown in Fig. 159.

The tufting chains must be intermittingly moved to bring the carriages with the spools into position for each successive row of fur and they must remain at rest long enough, to permit the tufting carriages with spools and tubes to be lowered from them while the tubes enter between the warp threads, for the formation of the fur, and the whole be replaced in the chains. This intermittent movement is obtained by the action of the pin wheel 44 and pin 44^1 on the hexagonal star wheel 46.

The main loom shaft 22 together with heald shaft 26 is timed to make one complete revolution, during the introduction and securing of one row of tufts and completion of one repeat of the foundation weave. The hexagonal star wheel shaft 46, through the medium of which the chains are moved must consequently make one sixth of a revolution to one of the tappet shaft 26, cam shaft 22 and the insertion of one row of fur.

The pin wheel 44 makes two revolutions to one of the tappet shaft 26 but the pin 44^1 which engages with the star wheel 45 is

automatically removed from contact with it on alternate strokes of the pin wheel. By this arrangement the star wheel is turned for one sixth of a revolution in *quicker* time, thus leaving it together with the chains at rest for a longer period in which to remove and replace the tufting carriages.

The circular motion of the pin wheel acting upon the star wheel produces a variable velocity in the star which is consequently an advantage, since it causes the chains to move slowly at first and gradually increase in speed until they reach the centre of their traverse and then to decrease in the same velocity ratio after which they dwell as stated above.

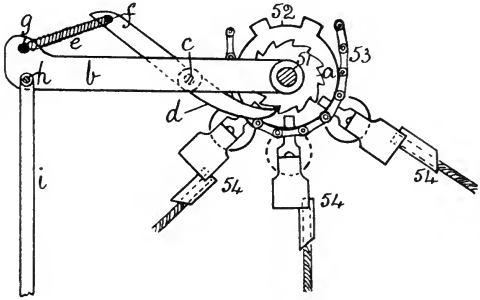


Fig. 158.

Any sudden movement or restraint would be injurious to the tufting mechanism. The simple clutch arrangement 43 is designed for the purpose of disengaging the tufting mechanism from its driving gear. Then by the application of a screw key to the square end of shaft 42, the chains can be turned either backward or forward by hand independently of other parts of the loom.

Ratchet driven Chain Wheels.

There are numerous ratchet contrivances in use for driving the sprocket chain wheels. The diagram at Fig. 158 is given to illustrate the general principle. The sprocket wheel shaft is shown at 51, the sprocket wheel at 52, the chain at 53 and the tuft spools, etc., at 54.

Mounted upon the shaft 51 is a ratchet wheel *a* and a short lever arm *b* is loose upon this shaft; a stud *c* passes through the arm *b* and supports a pawl *d* which is in operative position for turning the ratchet wheel *a*. A small spring *e* joins pawl *d* and lever *b* at the points *f* and *g* which tends to keep the pawl *d* in constant contact with the ratchet wheel *a*. A holding catch obviates any tendency in ratchet *a* to rotate backwards. A stud *h* passes through the lever *b* and a vertical connecting rod *i*. This rod is operated upon by a treadle lever which contains the usual antifriction bowl, being in turn operated upon by a positive tappet mounted on the cam shaft. This tappet is constructed set and timed to give the necessary variable movement to the sprocket chain wheels through the connections as described above.

General Notes on Tufting.

The tufting yarns of different colours are wound side by side on long spools or bobbins the width of the carpet and these spools are arranged in colour and juxtaposition to suit the requirements of the design. There are as many spools required as rows of tufts in one complete repeat of the design and each spool contains as many ends as there are tufts of pile across the width of the carpet. The colours represented on spool *b* Fig. 154 are coincident and in the same order as those on row 10 Fig. 174 page 245.

The yarns from each spool are passed over or about tension rods and thence through a series of *tubes*—one thread through each.

The tufting bobbins are each supported and carried by two endless chains whose 'length' is determined by the number of spools and rows of fur in each repeat of pattern.

The peripheries of the heads of the bobbins are acted upon by adjustable flat springs, the application of which force controls the tension and prevents the bobbin from over-running.

Holding the Tuft Yarns.

The tuft yarns are all clamped and held tight against a bar or other support during the insertion and formation of each row of tufts. The clamp consists of a long strip of rubber *k* suitably supported just above the entrance of the yarn into the tubes Fig. 154. This rubber and support

stretches the full width of the tubes, being in turn supported by two lever arms which are suitably alternated by means of two cams and the intermediary rods and connecting links.

Tufting—Wide Widths.

Where greater widths than 5/8 or 3/4 carpet are required to be woven the tuft yarn bobbins have an extra support near their centre and the tufting tubes are aligned by means of a bar which passes behind them and immediately under the frames to which the tubes are fastened. By this arrangement the tubes maintain their correct position and alignment throughout the whole width.

Formation of the Tufts.

Each bobbin and set of tubes with the carriages to which they are together attached are so placed in the chains as to be automatically detached and brought into operative position for the formation of each successive row of fur. When they are so taken down and brought into near contact with the fell of the cloth or reed, according to whichever method is employed, the tubes with their yarns are made to enter the spaces between the warp threads forming the upper division of the warp shed. The entrance is effected at a point midway between the fell of the cloth and the reed; the free ends of the tuft threads are arrested and held close to the fell of the cloth; the direction and angle at which the tubes enter the shed combined with the movement is such that the tuft yarns hanging from the descending tubes are trailed diagonally downwards into the shed, until the ends of the tubes with the tuft yarns form a sufficient space between them and the upper line of warp threads to admit of the entrance of a wire which usually carries a double shot of weft; about this double pick of filling and binding weft the tuft yarn is locked.

After the insertion of the binding or top weft, the fur tubes are lifted out of the shed and as they gradually rise, to clear the reed, their ends are moved forward towards the fell of the carpet, by which means the tuft yarns are wrapped about the double pick of filling; simultaneously with the forward movement of the tubes, the reed follows, presses against the tuft yarns and the enclosed weft and carries them on towards the fell of the carpet. While the tuft yarns, tubes and carriage remain in this position the warp

threads are crossed and the next shed is formed into which a second double shot of weft is inserted and beaten into the fabric to form the bottom shed and assist in holding the row of fur in the carpet. Meanwhile the tuft yarn tubes, etc., have been lifted high enough to draw off a sufficient length of yarn, at which stage it is cut, to form the next row of pile; after this the tubes spool and carriage are lifted back into the chains, moved onwards and the next spool brought into position to be treated like its predecessor.

As an alternative method the tuft yarn tubes may enter the shed at a point near the reed and the ends of the tuft yarns may be arrested by or through the reed; then the tubes move towards the fell of the carpet and thereby trail the tuft yarns into the shed and so form a space between the upper and lower division of the ground warp threads which permits a wire with the filling threads to enter between the upper line of warp threads and the tufting colours.

In either method the ends of the tufting material are never allowed to fall below the upper line of warp threads.

Transferring the Tufting Frames from the chains into the shed and vice-versa.

Three specially constructed tappets, a series of simple levers and rods and a compound lever mechanism have been designed and adapted to produce this necessary result; their united action is a forceful illustration of how tappets or cams can be constructed to produce any kind of variable and intermittent motion in bowls, levers, rods, etc. The combined action of these three tappets through their connections described below is concentrated in a compound lever, called a transferring arm, which operates upon the tufting frame to detach it from the chains, lower it into the shed, move it to and fro in and above the shed and return and replace it in the chains.

The *first* tappet regulates the chief movement upwards and downwards of the transferring arm so as to lower the tufting tubes, suspended from their frame into the shed between the warp threads and to lift the tufting frame back to the chains.

The *second* tappet operates in sympathy with the first to produce the to and fro movement of the tubes with the pile yarn in and above the shed.

The *third* tappet is confined to a lateral movement in the transferring arms when near the chains for detachment and replacement of the frames in them. The features of this necessary and important mechanism are illustrated at Fig. 159, which is a side elevation of one of the chains into which the tufting frames are placed and

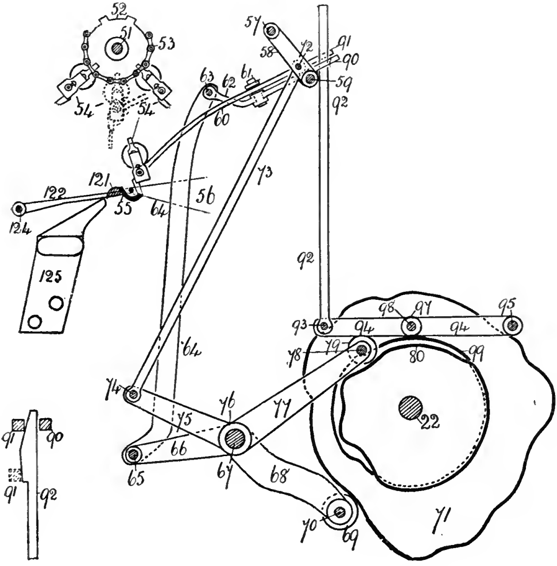


Fig. 161.

Fig. 159.

one of the sprocket wheels which supports and rotates the chains together with a vertical section through the tappet or cam shaft 22 and also an elevation of the three tappets, rods and levers which are necessary to produce the compound motion in the transferring arms. The illustration also shows the shed in elevation together

with a section through the weft and shed. A plan of the transferring arms is supplied at Fig. 160, to illustrate the method adopted to produce the required lateral movement in them. Beginning with the sprocket wheel shaft 51 on which the sprocket wheel is mounted for driving the tufting frame chains 53, all the combined parts of the tufting spool, frame and tubes are represented at 54. Their several and respective parts are illustrated and described in connection with Fig. 154. The warp shed is indicated at 56 and the fell of the carpet at 55. The essential parts of the operating mechanism are as follows:—To a shaft 57 fixed in the loom supports, a short lever 58 is centred and free to turn about it; the free end of lever 58 supports a swing shaft 59 in position above the warp threads; it reaches across the back of the loom being similarly supported at the opposite end; placed above this shaft near each end is a compound lever for detaching and transferring the tufting frame from the chains to and from the shed and replacing it into the chains; one of these levers is shown at 60, its duplicate which is not shown in the illustration is described as 60^1. The transferring arm 60 is mounted on a stud 61 projecting upwards from a second lever 62; this stud serves as a fulcrum about which it can turn in a lateral direction to release the pressure of spring *l* (Fig. 154) from the double link of the chain and thereby assist in detaching the carriages from the chains and also serve as the point of application for alternately lowering and lifting the frames. One end of the bent lever 62 is mounted on the swing shaft 59, through which connection the to and fro movements of the tubes in the shed are produced. The upturned arm of lever 62 is combined with a stud 63 to a vertical connecting rod 64 which is joined by a stud 65 to a lever arm 66 securely fastened to a shaft 67 which it is free to rock; the lever 66 belongs to a simple order being continued beyond the stud 67 as shown by the the arm 68 which carries near its terminus an antifriction bowl 69 on a stud 70; the bowl 69 is kept in rolling contact with a tappet 71 secured to the main or cam shaft 22. The *outline* of the traverse of this tappet and also of numbers 80 and 99 is only shown. By the revolution and action of this cam on bowl 69 and through parts just described the transferring arms 60

and 60^1 are elevated and depressed. Through the arm of lever 58 a stud 72 is passed and joins the lever to a connecting rod 73 which in turn is connected by a stud 74 to a lever arm 75 compounded with a sleeve 76 and an extended arm 77; the sleeve 76 is on and free to revolve about the oscillating shaft 67; the free end of lever arm 77 supports, with the aid of a stud 78, an antifriction bowl 79 which is kept in rolling contact with a cam 80 also on shaft 22. This second cam is so constructed that when it rotates in contact with the bowl 79 the latter, through connections described above, causes the trans-

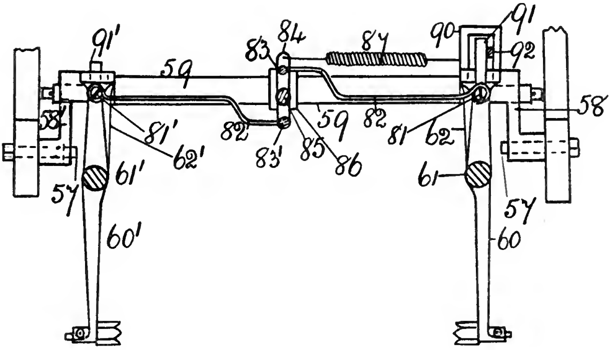


Fig. 160.

ferring arms 60 and 60^1 with the tufting frames attached to move backwards and forwards between the fell of the carpet and the reed for the purpose of trailing the tuft yarns into the shed and subsequently—after they are lifted out and above the shed, of carrying them towards the carpet prior to their being cut to form the fur. The transferring levers 60 and 60^1 are connected at their upper ends by studs 81 and 81^1, connecting rods 82 and 82^1 and studs 83 and 83^1 to a short simple lever 84 fulcrumed on a stud 85 between two collars 86 and 86^1 on the shaft 59, Fig. 160. See also Fig. 147. The transferring lever 60 has a projecting finger 91 which is kept in close contact with a vertical cam rod 92 the upper end of which is shown

separately at Fig. 161; it works in a loop 90 formed at the rigid end of lever 62 above shaft 59. The rod 92 is connected at its base by a stud 93 to a treadle lever 94 pivoted on a stud 95 fixed in the supplementary framework. An antifriction bowl 97 on stud 98 is kept in rolling contact with the third tappet 99 also on the shaft 22 Fig. 159. The action of this cam on bowl 97 and its connections serves to move the transferring arms 60 and 60^1 away in a lateral direction from the ends of the tufting frames, etc. A spiral spring 87 connects the lever 84 and loop 90 and thereby keeps the latter in close contact with the cam rod 92.

Combined action of the tufting-tappets

The separate action of the three tappets 71, 80 and 99 together with their respective connections with the transferring arms 60 and 60^1 are all combined to produce the compound motions required in this arm and which may be described as follows:—With the constant revolution of the tappet shaft 22 the three cams revolve; the cam 71 operating upon bowl 69 depresses arm 68 and rotates the rockshaft 67 clockwise, elevates arm 66, rod 64 and lever 62 with the transferring arm 60 until its free end is near the tufting frame etc. 54. Simultaneously the cam 80 acting upon its bowl 79 causes lever arm 77 to be lowered which rotates sleeve 76 clockwise so that the arm 75 rises and with it the connecting rod 73 which in turn operates upon the lever arm 52 and rotates it slightly together with the swing shaft 59 upwards to the right, pulling with it the stud 61 on which the transferring arm is mounted and thereby forcing this arm to a position immediately behind the tufting frame; next, this tappet acting on its respective bowl elevates it and through connections as above produces the reverse motion, thereby causing the free end of the transferring arms to move downwards to the left and so engage with the pin *l* and spring *g* to remove them from the chains (Fig. 154).

Meanwhile the tappet 99 acting in sympathy with its contemporaries exerts a lifting pressure upon the anti-friction bowl 97 and so elevates the treadle lever 94 together with the cam rod 92 which in turn presses the finger end of the transferring arm 60 so that it can move slightly and laterally in a direction away from the chains,

thus causing the clutch end of arm 60 which is now in the frame 54 and between the pin *l* and spring *g* to exert such a pressure on the latter that it releases its contact from the double link in the chains. The transferring arm 60^1 on the opposite side of the loom acts in a similar manner to detach the frame 54 from the chains. This is clearly illustrated in the plan Fig. 160 by the parts from 81 to 90 already referred to. The tappet 71 continues its journey and through its connections, previously described, lowers the arm 60 with the frame 54 etc. until the tubes with their suspended yarns are over the fell of the carpet which yarns are then arrested by mechanism to be described shortly. Simultaneously the tappet 80 exercises its influence through the medium of its connections upon the arm 60 and moves it with the tufting frame and tubes so as to trail the tuft yarn and tubes into the shed between the warp threads of the upper division. These two motions compounded and acting concurrently produce the diagonally downward movement of the tubes into the shed until they have receded a sufficient distance from the fell of the carpet to form a shed large enough to receive the wire containing the weft which is then set in motion and enters the shed between the tubes and the fell of the carpet under the upper line of warp threads and over the tuft yarns. The two tappets 71 and 80 acting concurrently produce the converse diagonal movement in the tubes until they are suspended above the fell of the carpet where they remain until the tufts have been beaten up by the reed and the next double shot of filling has been inserted. Then the tappet 71 continuing its rotation elevates, through its respective mechanisms, the tufting frame 54 etc. so as to replace it in the chains by pressing the pin *l* into the open space of the double link, after which the tappet 80 operating through its parts causes the arm 60 to recede from engagement with the tufting frames ready for repeating the compounded operations with the next and successive tufting frame, spools and tubes.

Arresting the Ends of the Tufts.

Immediately the ends of the tuft yarns have been laid on and near the fell of the carpet and prior to their being trailed into the shed by the tufting tubes, a yarn arresting device is designed

to lay hold upon the free ends of the fur and hold them until the formation of the pile has been completed. The mechanism which performs this operation (shown in elevation at Fig. 162) may be defined as follows :—

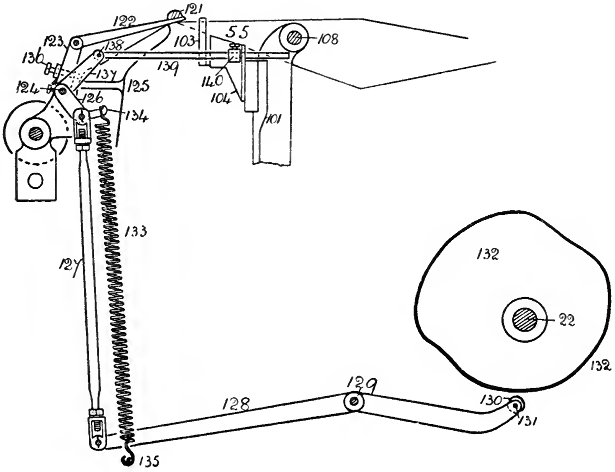


Fig. 162.

A straight bar 121 is extended across the loom just above the fell of the carpet ; it is supported by two levers 122 and 122^1—one at either end, the former only is shown in the diagram. The lever 122 is compounded with the arm 123 which is made fast to a rocking shaft 124 and also extended across the front of the loom and near to the breast beam 125 ; secured to the shaft 124 is a second arm 126 which through an adjustable connecting rod 127 joins a treadle lever 128 fulcrumed to the stud 129 ; placed at the opposite end of the treadle lever, on stud 131 is an antifriction bowl 130 which is free to revolve in contact with the tappet 132. A spiral spring 133 joins a bracket 134 on arm 126 to any convenient fixed

portion of the loom near its base as at 135 and through these connections it tends to move the bar 121 forward on to the tufts as the going part recedes. An adjusting screw 136 passes through arm 123 and rests against the breast beam 125 when the bar 121 is at its furthest point forward thus limiting the forward movement of arm 122 with the bar. A lever arm 137 fast on shaft 124 is joined by a stud 138 to a horizontal rod 139; the free end of this rod passes through the upper part of bracket 104 fixed to the sword 101 ; an adjustable collar 140 is fastened to this rod and is in position to be acted upon by the forward movement of the going part and thus the rod 139 can through its connections just detailed cause the arm 122 with the bar 121 to move to the left in sympathy with the reed, as the latter travels simultaneously behind the tubes towards the fell of the carpet.

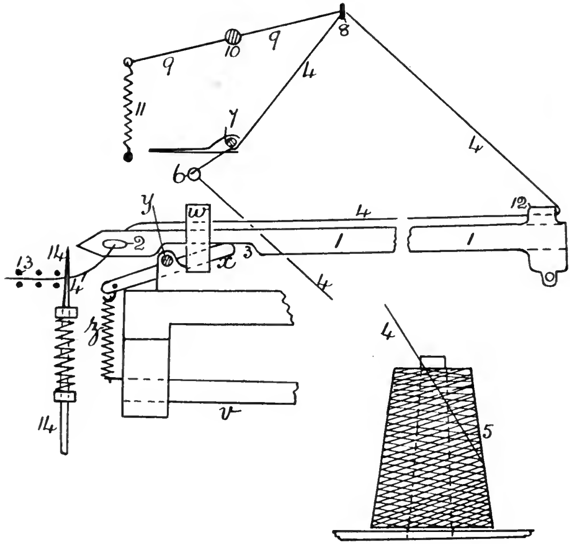
The action of the tappet 132 in pressing down the bowl 130, causes the lever 128 to turn clockwise about the stud 129 and elevates the rod 127 which acting upon the arm 126 makes the rocking shaft 124 turn counter-clockwise and consequently through arms 123 and 122 move bar 121 clear of the tufts and fell of the fabric, thus permitting a space for the tufts to be cut.

Picking—Positive.

The filling weft is inserted into each warp shed *double*, by means of a needle or wire usually called the weft carrier. The body of this wire is round and about half an inch in diameter. The wire and parts of the mechanism at the right hand side of the loom are submitted at Fig. 163. A view of the wire at the left hand side of the loom is given at Fig. 164, which also shows part of the mechanism designed to lock the double pick and prevent it from slipping or drawing backwards with the return journey of the wire. The needle is shown at 1 and the end which enters the shed is pointed and contains an eyelet 2 as shown, through which the weft is free to pass ; near this end and on the underside, the needle is preferably notched as at 3 for the purpose of facilitating subsequent binding. The cotton or jute weft 4 is contained by preference on large *conical* shaped bobbins 5, eight or ten inches in length which hold a large quantity of the material, and from which the yarn readily runs off. The

machine on which these bobbins are wound is illustrated on page vii. The weft 4 from the bobbins 5 passes through a guide ring 6 and under a tension bar 7 forward to and through the ring

Fig. 163.



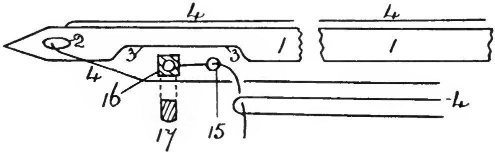


Fig. 164.

eye 8 of lever 9 which is free to rock on stud 10. The tension bar 7 tends to pull the ring 8 of lever 9 downwards. A spiral spring 11 operates in the opposite direction to take up any slack, in the return

journey of the wire during which period the yarn is pulled off the bobbin. From ring 8 the yarn passes forward to and through a projection 12 at the right hand end of needle 1 and then to the eye 2 and the fell of the carpet 13. At this point a vertical pin 14 rises up to assist in making a perfect edge, sinking again however before the sley 'beats up,' motion being imparted to it through the rotary action of a suitable cam. It will be perceived that with the return journey of the weft carrier, the filling material would be drawn out of the shed unless arrested and fastened at the edge of the carpet remote from

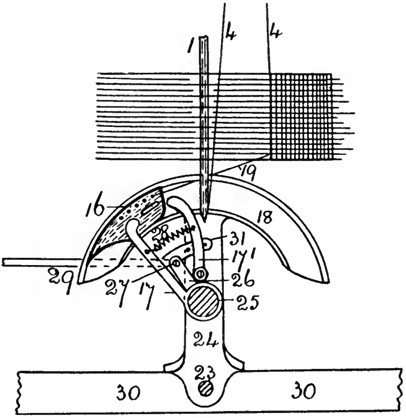


Fig. 165.

the wire motion. This is accomplished by the aid of a small shuttle which is similar to a sewing machine shuttle but about 3 inches in length and 1 inch in diameter, and which is made to pass through notch 3 in the needle and over the weft to secure it at the edge and so prevent it slipping backwards.

The shuttle to which a tension wire 15 is attached is shown at 16 and its propeller or hammer at 17. The traverse of the shuttle is semi-circular; it moves in a slide 18 which is suitably bolted in position 23 on the left hand side of the loom frame 30. A plan view of the propeller, shuttle and race is shown separately at Fig. 165.

The hammer consists of two arms 17 and 17^1 and is secured to a rocking shaft 25 in the race supporting arm 24. The shaft 25 receives its alternating movements through a short lever 26 also secured to shaft 25. A stud 27 passes through the free end of lever 26 and joins it to a connecting link 29 which in turn links lever 26 at right angles to a treadle lever not shown but acted directly upon by a suitable cam on the cam shaft. The hammer arms 17 and 17^1 are linked together by a spring 28 which yields to any variable pressure of the shuttle and pull of the binding weft.

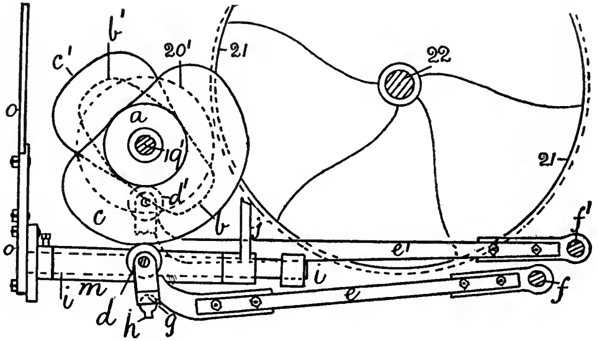


Fig. 166.

Mechanism for inserting the weft carrier.

Fig. 166 is an end view of the tappets and parts which impart the required reciprocating movement to the needle.

Fig. 167 is a front view of the same as seen from the right hand side of the loom.

The cam shaft is shown at 22 and a large spur wheel on this shaft gears into and drives a pinion wheel 20^1 on shaft 19^1 supported in suitable loom bearings. This shaft carries a sleeve *a* containing two flanges *b* and b^1; to these two adjustable tappets *c* and c^1 are respectively secured and operate by rolling contact with two anti-friction rollers *d* and d^1 which are free to revolve in the free ends of

the respective treadle levers e and e^1, fulcrumed as shown at f and f^1. In each treadle lever immediately underneath the bowls d and d^1 there are semi-circular sockets g and g^1; these fit on to the spherical ball heads of two lever arms h and h^1, the latter of which is secured to a rocking shaft i which supports and alternates a lever or picking arm o called the wire or needle lever, its function being

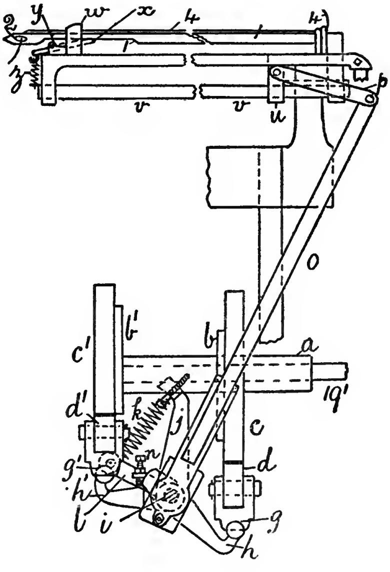


Fig. 167.

to propel and withdraw the carriage with the weft carrier; the former lever arm h is compounded with a sleeve m, but loose upon shaft i and near the remote end there is also compounded with the sleeve a lever arm j; a spiral spring k joins j to a lever arm l projecting from its hub which latter is secured to the rocking

shaft i, thereby constituting a connection between the rocking levers h and h^1 and so tending to draw them nearer each other or to rotate them in opposite directions, or, operating through them to cause the bowls d and d^1 to rise into contact with the tappets c and c^1. An adjustable nut n serves to determine the limit of their direction towards each other and of their contact with the tappets.

This spring is the factor which tends to cause the tappets to act positively upon the antifriction bowls. When the lever arm h^1 is depressed by its roller d^1, it operates through the spring k and arm l to turn shaft i counter-clockwise and insert the needle; when the lever arm h is depressed by its respective roller d it rotates the shaft i clockwise to withdraw the wire.

Securely fastened to the shaft i is the propelling lever arm o; a connecting link p joins this arm to the needle carriage u which is free to slide along the straight bar v. The needle 2 is supported above the carriage at one end, the other end being free and passing through a guide w to the fell of the carpet and into the shed as required. The guide w is recessed sufficiently to admit the full diameter of the needle and so to allow of it travelling through, but the recessed end of the needle has a tendency to fall.

This is counteracted by the adjustment of a small and simple lever x on stud y, connected to a spiral spring z on the frame work as shown. The combined action of this spring and lever tends to keep the front end of the needle in its most elevated position in the guide w as required. See also Fig. 163.

Reciprocating motion is imparted to the needle by the constant rotary action of the tappets c and c^1 operating through the mechanism already described.

Theoretically the wire should commence to move slowly at first, and gradually increase in speed until it reaches the centre of the shed, when it should decrease in the same velocity ratio until the extremity of the throw of the wire is reached, then dwell for a brief period to allow time for the small binding shuttle to pass between the filling weft and the notch 3 in the wire 1 and thereby prevent the filling from being drawn backwards on the return journey of the weft carrier, during which traverse it lays the second line of filling.

This is not only a matter of preference but of necessity with a positive picking motion and the production of satisfactory edges, while at the same time the introduction of two shots of filling is not an objection but rather an advantage in carpet structures such as Axminsters, since the tuft can be more firmly fastened around two filling threads than one. When two or more kinds of filling weft are to be inserted a corresponding number of weft carrying needles are simultaneously passed through suitably formed sheds.

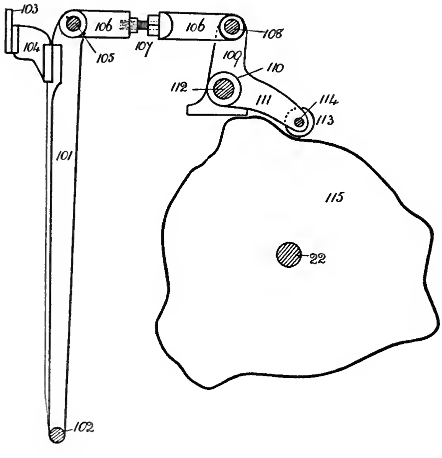


Fig. 168.

Beating up the Weft. The reciprocating movement of the lay of the going part required to beat up the weft into the carpet is produced by means of a specially constructed tappet placed on the main or cam shaft of the loom which cam operates through rods and levers to produce the required number of beats of the reed, according to the pattern. Fig. 168 is an illustration in elevation of such an arrangement for making three beats of the lay during the insertion and completion of one row of

fur. The sword of the going part 101 is pivoted and free to make its reciprocating movements on the rocking shaft 102. The reed 103 is supported in a bracket arm 104 near the top of the sword. A stud 105 joins the upper end of the sword with an adjustable connecting link 106; the small bolt and nut 107 combined give the necessary adjustments; a stud 108 passes through the right hand end of the link 106 and through the lever arm 109 which is compounded with a sleeve 110 and a second arm 111, all on a fixed stud 112. The arm 111 supports an antifriction bowl 113 on stud 114. A tappet 115 on cam shaft 22 is kept in rolling contact with the bowl 113. This tappet has been designed to produce three beats in the lay and reed during the insertion of each row of tufts and through connections already described combined with the constant rotary motion of the cam shaft it produces the alternating and eccentric movements in the lay of the going part.

Taking up the Carpet.

The woven carpet passes over a spiked roller which is rotated positively by one of the following methods.

Part of Fig. 148, page 214, shows in elevation an arrangement, which in principle is identical with that illustrated and described at Figs. 61 and 62 on page 117 and consequently need not be repeated here. The same numerals in Fig. 61 with the exception of 53, 54, 55 and shaft L, refer to corresponding parts of the above figure.

An alternative method of taking up is frequently adopted as illustrated at Figs. 169 and 170. The former shows a side and the latter a front view. To one end of the shaft H which passes through the spiked carpet roller G a spur wheel A is secured; this receives a rotary motion from a small pinion change wheel B compounded with a large ratchet driven wheel C on stud D about which they are both free to turn. A small holding catch E on a stud F is kept in close contact with the ratchet teeth and prevents the wheel C from slipping backwards. A pulling catch or pawl M is supported upon a stud N in the free end of lever I secured to a stud shaft J, which is free to rotate in bearings of the loom frame; behind the lever I and on the inside of the loom frame is a second short lever K

also secured to the shaft J; to the lever K a connecting rod L is connected with suitable mechanism so as to impart a rising and falling movement of the levers K and I with each alternating movement of the lay; the latter lever being kept in close contact with the ratchet wheel C is regulated to move this wheel, usually a distance equal to the pitch of one tooth which latter through its connections described tends to rotate the spiked roller G and take-up the carpet. A worm O on shaft H gears into and rotates an index worm wheel P, on a fixed stud Q. Each revolution of the roller G

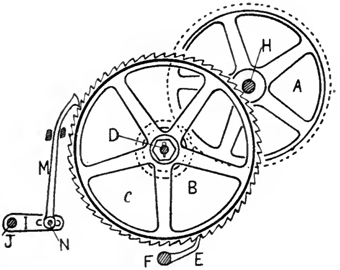


Fig. 169

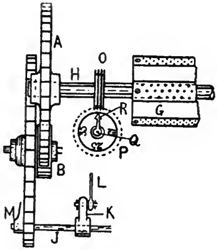


Fig. 170.

and shaft H represents a half yard of woven carpet; the index finger R shows at a glance the length of carpet woven at any given period.

Warp controlling mechanism.

Frequently there are three separate lengths of warp required in an Axminster base structure. In all such cases three warps require to be dressed upon different warp beams so that they can be separately tensioned. There are several methods adopted for regulating the let off of these warp beams; generally the small chains are controlled positively but the stuffer is sometimes negatively and at other times positively let off.

In the following illustration all three are represented as being regulated by a positive motion. Fig. 171 is a vertical section through the warp beams, tension bars, healds and other details.

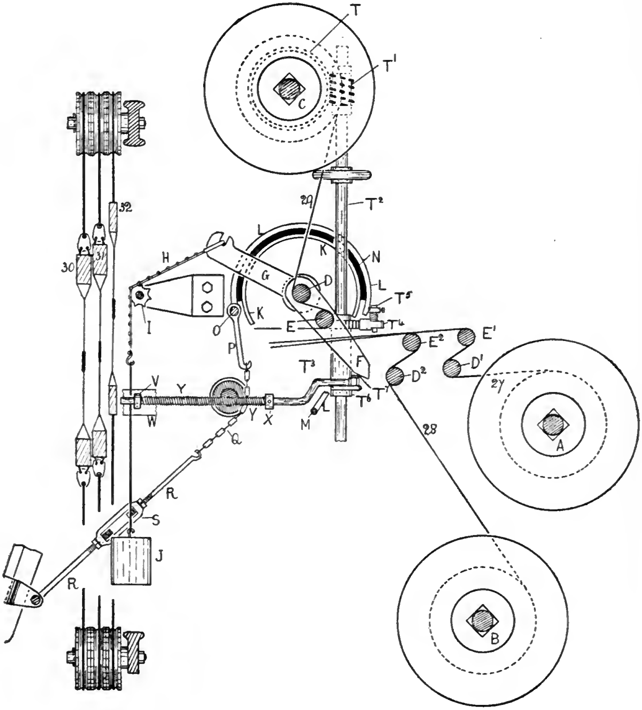


Fig. 171.

The principles of this mechanism though in some respects dissimilar, are in many details coincident with the jumbo warp controlling motion fully described and illustrated in connection with Figs. 54

and 55 page 112 for which reason a description of the above illustration is somewhat abbreviated. The long, short and stuffer chains 27, 28 and 29 are wound respectively upon the beams A B and C. The ground chains 27 and 28 pass behind stay rods D^1 and D^2 and in front and over bars E^1 and E^2 respectively to the healds; the mechanism which operates upon the stuffer beam is only shown; each of the other beams is controlled by duplicate mechanism. D represents a stay rod which is supported and free to rotate in suitable bearings at opposite sides of the loom; a swing roller bar E is supported in the arm of lever F which is compounded with the lever G fixed and free to rotate the stay rod D slightly. To the arm G a chain H is attached which passes over a sprocket guide wheel I on stud and bracket as shown and suspended to the lower end of the chain is a dead weight J. At the remote end of shaft D and secured to it is a segment brake wheel K; one end of an iron brake L is fastened to a fixed stud M in the loom frame and then passed over the periphery of the brake pulley; a thick piece of leather N is interposed between the brake and the face of the pulley to increase the gripping properties of the former; the opposite end of the brake is attached by a stud O to a hook P; a chain Q passes behind a guide roller as shown and joins P to an adjustable connecting link R, the swivel S being the adjusting factor combined with the threaded portion of R as shown. The lower portion of link R is secured to the sword of the going part near its base by a bracket and stud as shown. To the remote end of the warp beam C a worm wheel T is secured which combines in gear with a worm T^1 securely fastened to an upright shaft T^2 suitably supported to the loom and partially controlled in its rotary motion by a clamp attachment not shown. A ratchet wheel T^3 is secured to the shaft T^2 and a pawl T^4 on stud T^5 is kept in close contact with the teeth of the ratchet wheel by the usual means of a spiral spring. A short lever T^6 with a stud T^7 is also made fast to the shaft T^2. One end of a plunger rod fits on the stud T^7 and the opposite end passes freely through a bearing V in the framework W; an adjustable collar X is fixed to the plunger rod and between it and the bearing V is a spiral spring Y which encircles the rod.

The action of the foregoing mechanism and its principle of letting off is as follows:—With the upward and downward movement of the healds the pressure is applied to the swing shaft E to produce a slight rotary movement about the centrally fixed shaft D clockwise; the arms F and G also move slightly in the same direction. The arm F presses against the short lever T^6 to turn the shaft T^2 and through worm T^1 and worm wheel T causes the warp beam to revolve very slightly and so unwind its web. The spring Y on the plunger rod contributes to retard any undue forward movement of lever F as well as to force back the shaft T^2 with ratchet wheel T^3 the teeth of which are kept in close contact with the pawl T^4. The weight J also operates by its own gravity and through its connections to retard any undue rotation of the lever arm C. Meanwhile the lay operating through the connecting link R and chain Q upon the brake L, tightens it upon the face of the segment pulley K and holds it together with the shaft D, arms G and F and shaft E in a perfectly rigid position while the reed strikes the weft and fur into the carpet. Thus the warp and its contemporaries are kept straight and any tendency to curl up on the back is avoided.

Designing and Colouring.

Axminsters, as compared with any other machine made carpets, permit of the greatest possible variety and freedom in design and colour.

Every thread on each tufting spool may be of a different colour and since each row of tufts requires a separate tufting spool a design which is 40 inches long and contains six points or rows of tufts per inch, would require $40 \times 6 = 240$ spools. This would not be considered a large number for it is quite easy to accommodate and operate a much greater quantity than 240. Generally the length of the design is merely a matter of convenience to save altering the loom. The pitch or number of points per square inch vary according to the quality of the carpet, 6×7 and 7×7 being standard sizes but the following and other sizes are also frequently made:—$5 \times 5\frac{1}{2}$, 5×6, 6×6, 6×7, 7×7, 7×8, 8×8, 8×9, 9×9, 9×10, and 10×10 points of fur per square inch.

Three different pitches of point paper used are illustrated at Figs. 172, 173 and 174. The first, it will be noticed, contains 5 × 6,

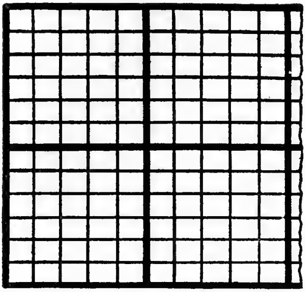


Fig. 172.

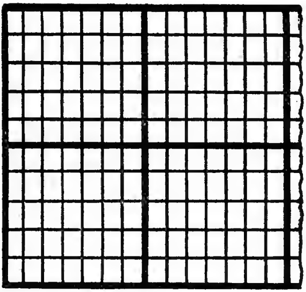


Fig. 173.

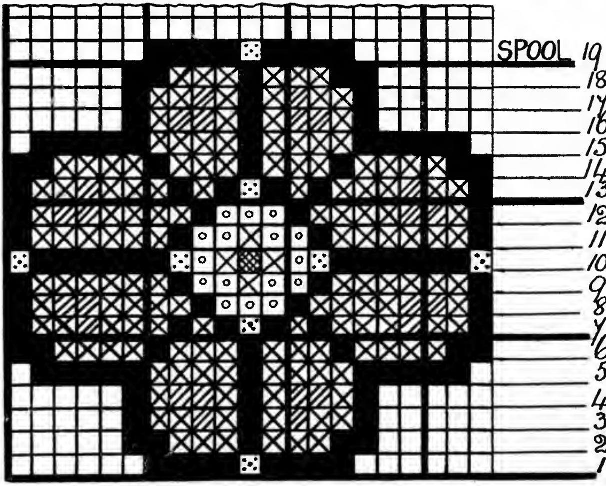


Fig. 174.

the next, 7 × 5, and the third 6 × 6. Upon the third a small detached figure is sketched and developed in different markings to

represent the several colours used and also to illustrate the smallest delineation it is possible to portray.

Each spool for the following widths of carpet usually contains:

1.	$\frac{1}{2}$ yard,	126 coloured threads	=	7 points per inch	
2.	$\frac{5}{8}$,,	157 ,, ,,	=	,,	,,
3.	$\frac{3}{4}$,,	189 ,, ,,	=	,,	,,

and the following lengths of each repeat of design frequently contain

1.	18 inches,	126 bobbins or tufts	=	7 points per inch	
2.	27 ,,	188 ,, ,,	=	,,	,,
3.	36 ,,	252 ,, ,,	=	,,	,,
4.	45 ,,	314 ,, ,,	=	,,	,,

Whenever designs are required to be woven 10 × 10 points per inch as is frequently the case in a Crompton Axminster Loom, the following number of pile threads for the given widths and lengths of pattern are respectively used.

$\frac{1}{2}$ yard contains	180 threads	×	180 tufts
$\frac{3}{4}$,, ,,	270 ,,	×	270 ,,
1 ,, ,,	360 ,,	×	360 ,,
$1\frac{1}{4}$,, ,,	450 ,,	×	450 ,,

The significance of the foregoing factors lies in the fact that the product of the number of threads in the width and the tufts in the length represents the possible number of individual tufts and colours which can be used with any of the given dimensions of pattern. These particulars are also the guiding factors in the selection of the sizes of design or point paper since every longitudinal divisional space represents a thread on the tufting spool and each horizontal divisional space a tufting spool itself.

While it is possible to use such an unlimited number of colours free from all thought of planting as in Brussels and Wilton carpets etc., from two to three dozen should be ample and it must be borne in mind too, that unlike Brussels or Wiltons, the colouring *cannot* be modified in the loom; to improve a poorly coloured Axminster would involve almost if not quite as much labour as the creation of a new design. These facts combined with the unlimited possibilities of colouring (while in most respects an advantage) make it imperative that a designer and colourist for Axminsters must be first and foremost a colourist by nature or art, except, perhaps, for very simple effects of pattern.

CHAPTER VIII.

'Chenille' Axminster Carpets.

Chenille or patent Axminster carpet manufacture was first introduced by Mr. J. Templeton, of Glasgow, during the years 1838 and 1839. The completed fabric is the product of two separate and distinct weaving processes, viz:—

1. Weaving the weft, pile or fur, generally styled the 'chenille weaving.'
2. Weaving the carpet proper, usually described as the 'carpet weaving' to distinguish it from the preparation of the weft.

The distinctive feature in this class of carpet is the 'fur,' prepared in the form of a long chain, which in addition to forming the 'velvet pile' also manifests the pattern in different colours; *each separate tuft may be distinct in colour from the rest,* hence there is no limit to the number of colours which may be used and in addition this system affords great latitude in the pitch or fineness and quality of materials employed.

Design and Sizes of Paper.

The figure is designed and coloured on the same scale as the actual size of the rug or carpet; specially prepared and ruled paper is used for this purpose, a portion of which is shown at Fig. 175, page 259. For strength and in order to keep the various strips and edges of the design rigid and intact the paper is frequently made up of three materials, the centre one being cloth. The pitch is a very variable factor—most manufacturers have their own; in a standard rug size there are 18 × 6 divisions in every *2 inches square* which is the unit generally used to express the pitch; other useful sizes are 12 × 6, 18 × 9, and 24 × 12. These respectively represent 3, 4½ and 6 tufts per inch and the last is a typical size for carpet structures.

Each horizontal row of spaces represents one line or shot of fur across the full width of the rug or carpet. The longitudinal rows represent the *fur weft.*

Fur Chain. The fur pick is first prepared by weaving in the form of an ordinary piece with differently coloured wefts to suit the colours in each horizontal row of the design paper. But since the width (and subsequently depth) of the fur, in practice called 'scale,' is only a part of an inch a series of such widths denominated 'strips' are woven side by side in the loom, the

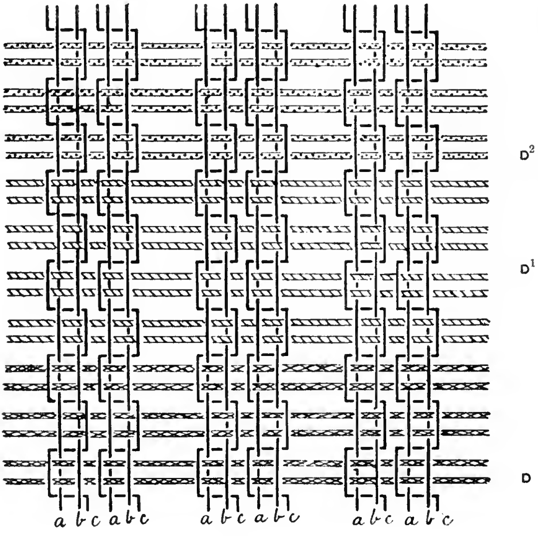


Fig. 176.

number of which is determined by the repeats of pattern or rugs required. All the strips in the woven fur, before cutting, are exact duplicates of each other and every one is made to such a length as to equal the total amount of fur required for one repeat of pattern. An enlarged plan of three strips of fur woven together is illustrated at Fig. 176. The different markings represent the variously coloured

worsted weft threads constituting the fur D. The fine warp or binding threads of cotton are shown at *a b c*.

Note:—A considerable number of fabrics are made which contain only one shot of fur D instead of two as in the example given.

It will be observed that these strips of fur are woven on the gauze or leno principle, so as to prevent the threads from slipping out or working loose when subsequently in the form of pile or fur. The strips thus woven side by side are taken to a cutting machine, described later, where, by cutting, heat, moisture and pressure they are each simultaneously forced to assume the desired and exact shape, so that what was only a few minutes previously a piece of cloth of considerable width—variously and peculiarly coloured, is now converted into an equal number of strips of fur, coloured to agree exactly with its given horizontal row on the point paper design.

Fig. 177.

Fig. 178.

Fig. 179.

A strip of fur after cutting is shown separately at Fig. 177. The same strip cut and folded at Fig. 178, and a transverse section of a series of these at Fig. 179.

Suitable Makes of Fur. The following particulars of make are for 60, 96 and 112 duplicate strips of fur respectively.

I. 60 strips of fur in 33 inches.

Warp.	*a.* & *b.*	2 threads of 2/24s cotton		1 split dent.
	c.	1 „ „ 3/60s „		
	a. & *b.*	2 „ „ 2/24s „		1 dent.
	c.	1 „ „ 3/60s „		

Miss 11 splits and repeat as above 62 times.

Width of reed = 33 inches.

Splits per inch = $27\frac{1}{4}$.

Weft. 2/4s Worsted, containing $1\frac{1}{2}$ turns per inch.

Picks per inch = 12, or as many double picks as there are single longitudinal threads in the point paper design per inch.

When each strip is cut, the length of the fur across will be just over half an inch, or exactly

$$\frac{33 - \text{edges.}}{60} = \frac{32 \text{ inches}}{60} = \cdot 53 \text{ inches.}$$

so that when each strip is folded the depth of the fur is about a quarter of an inch.

Note :—$1\frac{1}{8}$ yds. of 2/24s cotton warp is required for 1 yard of fur, and $2\frac{1}{2}$ yds. of 3/60s ,, ,, ,, ,, ,, ,, ,,

II. 96 strips of fur in 39 inches.

Warps as No. 1. Two full splits.

Miss 8 dents or splits and repeat as above 98 times.

Width of warp in reed = 39 inches.

Splits per inch = $25\frac{1}{4}$.

Weft. 2/5 Worsted.

Picks per inch = 18.

III. 112 strips in 38 inches.

Warps.

a. & *b.* 2 threads Cotton	}	1 dent or split.
c. 1 ,, ,,		
a. & *b.* 2 ,, ,,	}	,, ,,
c. 1 ,, ,,		

Miss 8 splits and repeat 114 times.

Width of reed = 38 inches.

Splits per inch = 30.

Weft. 3/12 Worsted.

Picks per inch = 24.

The first two of these 'fur strip makes' are suitable for rugs and the last for a finer grade of carpet in quality and pitch.

Weaving the Chenille Fur.

Cross or Guaze Weaving.

The two fine cotton warps are placed in a small power loom of common construction, the chief feature of which is the gauze mechanism.

There are several mechanical devices on the market which are used for the purpose of producing this kind of cloth structure. Two methods only are explained here and when the reader has

thoroughly comprehended these, he will have fully grasped the essential principles of 'cross weaving' which it is absolutely necessary to understand before 'chenille fur' can be intelligently produced.

The first method is illustrated at Fig. 180, which shows the warp threads passing from the warp beams to and through the mails of the healds and forward to the cloth.

Fig. 182. Fig. 184.

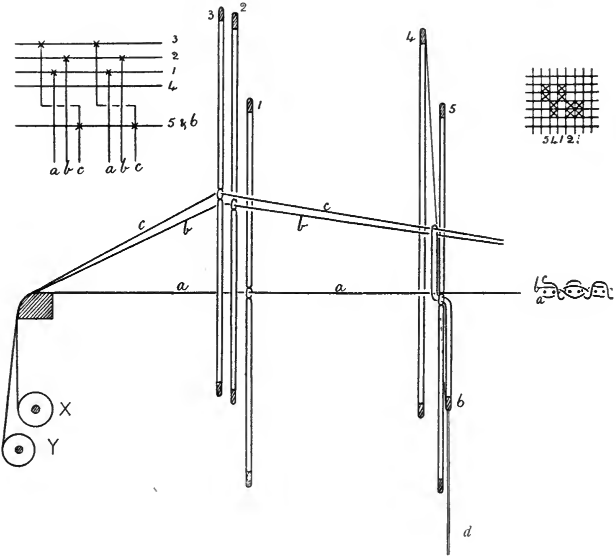


Fig. 180.

In cross weaving there are two kinds of warp—the straight threads *a.b.* and the crossing or gauze threads *c*; these are wrapped on to beams *x* and *y* respectively. There are three ordinary heald shafts 1, 2 and 3 also a half heald 6 called the 'doup' or 'slip'; a skeleton or dummy shaft 4 which is used for the purpose of lifting the slip only and a 'standard' heald 5 whose function is to support the

slip 6 the free end of which is passed through the mail of the standard heald 5 as shown. A string connects the bottom of the slip 6 with the top of heald 4, by which arrangement the slip can be lifted independently of the standard heald 5. A piece of elastic *d* pulls the slip back into its normal position immediately the pull of *c* is relaxed by the depression of heald 4.

The doup standard 5 and half heald 6 form one of the special features of gauze or cross weaving. There are various ways of combining the standard heald and the slip. Three methods are illustrated at A B and C, Fig. 181. In each of these systems the *half* heald cords are contained on a single stave or shaft, which runs alongside the lower stave of standard 5. In the diagram A each slip of half heald 6 is separately passed through its respective mail of heald 5. The crossing thread *c* passes through the loop of slip 6 and so long as it remains unbroken, the heald cord or slip remains intact, but immediately the crossing thread breaks, the respective slip falls on to the stave, and requires to be first picked up and again passed through its corresponding mail in standard heald 5, before the broken gauze thread can be adjusted.

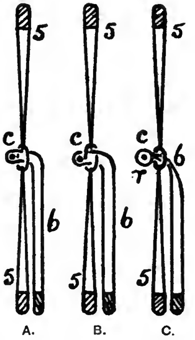


Fig. 181.

The diagram B shows how the slip 6 may be interlaced through the mail of heald 5 in such a way that should the crossing threads break, the cord of slip 6 cannot fall below the mail; consequently the broken warp can be readily "taken up."

In the diagram C the free end of slip 6 is fastened to a small brass ring *r*, which is larger than the 'eye' of the mail of standard 5; through this ring the crossing warp is drawn, and if it breaks, the ring *r* keeps the slip in its normal position.

Gauze Draft. The draft *i.e.* the method of drawing the warp threads through the mails of the healds and doup constitutes an important feature of gauze weaving. First, the

threads are drawn through the healds in the ordinary way; next, the ends from one shaft are *crossed* underneath the adjoining warp thread or threads; in the example given one thread *c* is crossed under two threads *a* and *b*, this crossing thread is then passed through

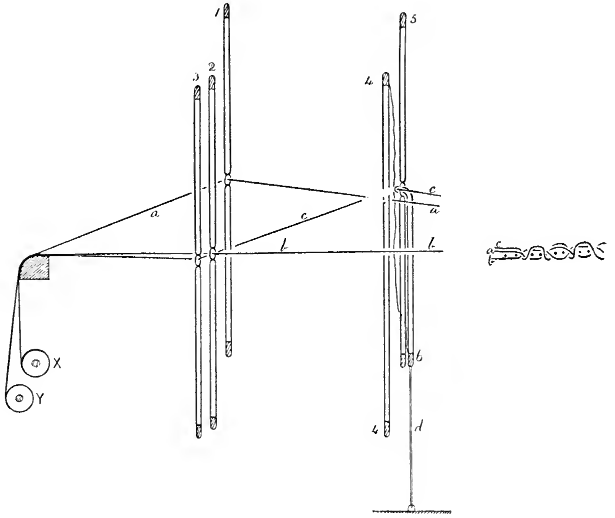


Fig. 183.

the slip or doup 6 as shown in Fig. 180. The *plan view* of this draft is supplied at Fig. 182. This is the common method of representing on paper the order in which the warp threads are drawn through the healds. The letters and numerals represent the same parts as in the Figs. 176, 180 and 181. The horizontal lines represent the heald shafts and the vertical lines the warp threads. The crosses indicate

that the warp thread is drawn through the mail of the heald shaft on which it is crossed *e.g.* Thread *c* is drawn through the mail of shaft 3 and threads *a* and *b* are drawn through shafts 1 and 2 as shown; *c* is then passed underneath threads *a* and *b* and through the slip as indicated by the cross.

This represents one repeat of the draft.

Treading plan.

In gauze weaving there are two distinct kinds of shed to be produced viz:—

The natural or open shed, see Fig. 180 and the crossing or gauze shed, see Fig. 183.

The letters and numerals of like characters in each diagram refer to corresponding parts.

It is in the formation of the *gauze* shed where the chief difficulty in gauze weaving is experienced.

The treading plan is shown at Fig. 184. On the first and second treads which represent the open shed, shafts 2 and 3 are lifted; the skeleton shaft 4 also rises and carries with its ascent the slip 6 and since the 'standard' 5 is down, it allows the thread *b* to rise and carry with it the free heald cord on its own natural side, but the third and fourth treads produce the gauze or crossing shed. Here it will be observed that the 'standard' with the slip is lifted on the remote side of the threads *a* and *b*. This lift is known as the 'cross' shed. Simultaneously with the elevation of the doup and 'standard,' number 1 heald shaft is lifted so as to produce the opposite ground shed.

Easing the Crossing Threads.

At this juncture it is opportune to note that the distance over which the open shed is formed reaches from the back rest to the fell of the cloth, whereas the space available for the formation of the gauze shed is only from the front of the ordinary heald to the fell of the cloth, the result of which is, that the crossing warp forms a very acute angle at the healds, though this can be neutralised slightly by allowing as great a space as possible between the ordinary healds and the doup standard.

There is nevertheless a greater strain on the crossing threads during the formation of the gauze shed, hence it is necessary to devise some means whereby this *excessive strain* may be reduced. Usually this is accomplished by an arrangement called an "Easing Motion." The principle of easing the crossing threads with the foregoing arrangement is a very simple one. The same is illustrated at Fig. 185 where a back view of the warp beam on which the crossing threads are wrapped is shown. Number 1 represents a steel collar and flange secured to the warp beam 2; around this collar a twitch rope 3 is coiled, one end of which supports a dead weight 4. The other end is firmly fastened to some strong rubber 5 consisting of several flat strands with an aggregate diameter of about half an inch. The chief feature of this principle is, that when the gauze shed is being formed, the pull on the warp aided by the weight 4 is sufficient to overcome the resistance in the rubber 5 and thus to slacken the warp as circumstances require. Immediately the tension on the warp is relaxed, the elasticity of the rubber reverses the motion of the warp beam and thereby takes up any slack warp threads. The peculiar feature of this method is that it serves to regulate the 'letting off,' not only for the gauze but also for the open shed, the only difference being that the rubber is not stretched as much on the open as on the crossed shed.

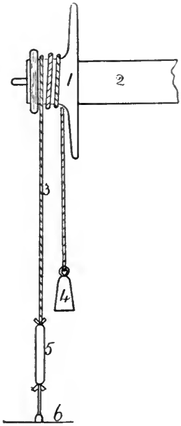
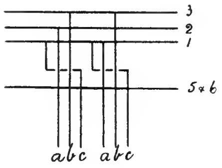


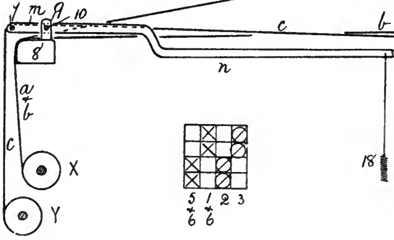
Fig. 185.

Another Method A plan view of the draft for an alternative method is shown at Fig. 186. In this as in the previous example there are three threads in each repeat of the draft. These are first drawn through the healds in the usual order 1, 2, 3, after which the doup and standard are placed in front of the ordinary healds, then the thread *c* from number 1 heald is crossed under two threads *a* and *b* in healds 2 and 3 and 'loomed' through the slip 6.

The pattern to be produced is the same as indicated at Fig. 176. The treading plan for this draft is supplied at Fig. 187. The heald mounting arrangement and slackener are illustrated at Figs. 188 and 189, the former of which represents the gauze and the latter,

Fig. 186.





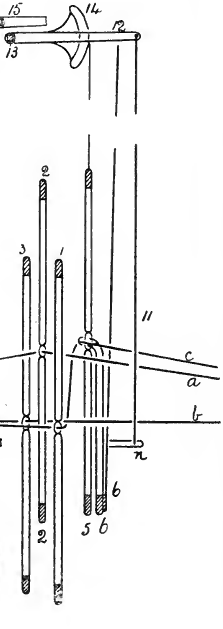


Fig. 187. Fig. 188.

the open shed. The chief feature of this arrangement is the slackener; here the crossing threads are all passed over a steel rod 7, which is placed immediately above and parallel to the back rest 8. The rod is supported in the arm *m* of the bent lever *m n*,

and is free to vibrate to and from the back rest 8; the lever *m n* is in turn supported by a bracket 9 and is free to move about the point 10. A connecting rod 11 unites lever *n* with the lever 12 fast on 'square' rod 13; to this same shaft the half moon lever 14 is

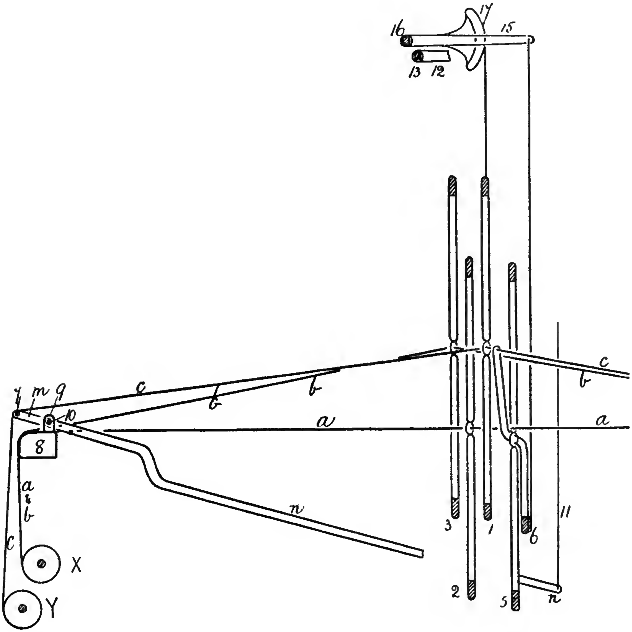


Fig. 189.

fixed and a cord connects it to the doup standard 5. The slip 6 is connected with the lever arm 15, which is fastened to the "square" rod 16; the quadrant lever 17 is secured to this rod also, which lever is connected to and elevates heald number 1. The healds 2

and 3 are independently joined to their respective half moon levers secured on the usual square rods. Motion is imparted to the above mechanism through the rotary action of negative tappets. In this system the best results can be obtained by using a single lift mechanism constructed to produce a "closed" shed on either the bottom or centre shed principle. The negative and open tappet system of shedding is however frequently adopted.

The principle of regulating the tension on the warp may be described thus:—When the gauze shed is required, the doup and doup standard are lifted through the controlled action of the tappet or other shedding mechanism; simultaneously the arm *n* of lever *m n* is correspondingly elevated, but the arm *m* lowers towards the back rest, thus permitting the rod 7 together with the warp threads to descend also; this depression shortens the distance traversed by the warp threads from the beam to the healds and so slackens the gauze threads sufficiently to permit a shed being formed between the mails of the ordinary healds and the fell of the cloth, of sufficient depth to allow the shuttle to pass through. When the open shed is being formed the doup standard descends as does also the arm *n* of the lever *m n* and a spiral spring 18 acting from the underside pulls this lever into its original position. Then healds 3 and 1, the latter of which carries the crossing threads, rise and slip 6 must also rise independently of the standard on this tread, pick or shed which it does in sympathy with heald 1 as shown in the illustration.

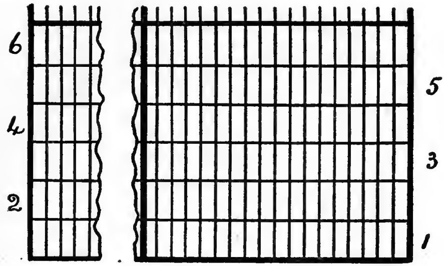
The Design in Strips.

After the design has been prepared and coloured each row of fur is consecutively numbered, the odd numbers on the right hand and the even rows on the left hand side beginning in each case at the bottom end of the design as shown at Fig. 190. For convenience of weaving, the point paper design is cut up into strips each containing two horizontal rows of the design as indicated at Fig. 191 which is equivalent to two rows of fur. These strips are called 'cords.' The several colours on the cords or strips of design paper are indicated by the respective markings as shown.

Inserting the Colours of Chenille Weft.

A separate shuttle and colour of worsted weft is required for each colour the design contains. Then since there are usually a large number of colours in one repeat of pattern which is always of considerable length *i.e.* equal to the total length of every row of tufts

Fig. 175.



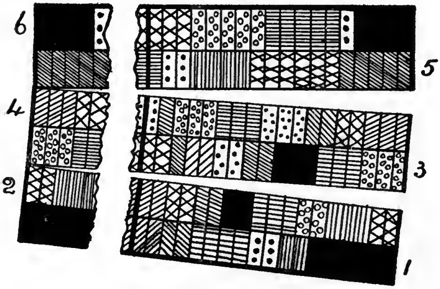


Fig. 190.

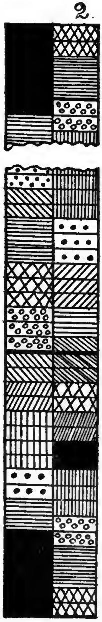


Fig. 191.

if placed end to end, the shuttles are arranged in a convenient position and inserted into their respective sheds by hand. The chenille weaver first takes each cord or strip of design paper in its proper order one at a time, puts it through a wide division in the reed near the right hand side and fastens it to the fabric by means of a

spring clip, the opposite end of each being suitably tensioned. The longitudinal lines of the full design paper have now become the transverse lines for the narrow strip to every *one* of which *two* shots of chenille filling weft are inserted.

The work of the chenille weaver is to weave a series (side by side) of narrow strips of cloth which when woven shall be identical in colour and appearance with the design cord, *e.g.* In Fig. 191 the first division of number one cord is maroon so the weaver selects the shuttle containing this colour and inserts two shots of worsted weft; on each of the next five divisions above, the same colour is required, consequently the loom is allowed to run for ten more picks. For the seventh and eighth divisions crimson is required accordingly a 'crimson' shuttle is inserted for four shots of weft, then in the next two sections of the same cord cardinal is selected and inserted by hand for four shots of weft. This operation is repeated until all the colours indicated in number one cord have been woven. Then for the second row of fur in this cord and for all subsequent *even* rows, the weaver turns the strip round and commences to read from the *opposite* end and to insert the colours in accordance with the markings. Each strip in its turn is always fastened to the fabric and carried forward with the insertion of each pick of filling and take up of the texture during actual weaving, in such a manner, that the colours in the design cord are in the same horizontal plane as those in the fabric and as a consequence it is an easy matter for the weaver to determine the correct colour for insertion. The process just described is repeated until the whole of the design cords have been reproduced in the woven fabric. When the rug or carpet has to be subsequently woven in a *hand* loom, a mark is made after every twenty rows of chenille fur has been woven, since this represents the total length which can be conveniently put upon a stick or shuttle; but when the fur is *automatically* inserted into the carpet the whole length can be woven without any break, though finer shots of worsted weft are often inserted to facilitate the subsequent turnings at the edges of the carpet, or other picks are put in which are subsequently extracted by the carpet weaver.

Length of Fur required for each Rug or Repeat of Pattern.

Generally, rugs are designed to turn over and repeat backwards or they may be and frequently are made to 'wield' round as technically expressed.

Fig. 17 Plate C is an example of the former and Fig. 18 Plate D of the latter type.

In each of the above figure designs, there will be two shots of fur alike in the woven carpet. Consequently when a chenille piece is woven with 60 strips of fur as in example 1, page 249, there will be just sufficient material to produce 30 rugs. The two following examples will help to make this section clear.

Example I.

Assuming it is required to weave a stair carpet 18 inches wide of which the pattern is 9 inches long and the number of shots of fur 6 per inch, what length of fur will be required to weave one repeat of pattern and how many yards of carpet will 96 strips produce.

Then $\dfrac{\text{width of stair pattern} \times \text{length of pattern} \times \text{shots of fur per inch}}{\text{inches per yard}}$

$= $ yards of fur chain required for each repeat of pattern.

$$= \frac{18 \times 9 \times 6}{36} = 27 \text{ yds. of fur chain for 1 repeat.}$$

And, No. of strips $\times$ length of pattern in yards $=$ yards of carpet.

Then since each strip of fur (27 yards) will produce one repeat of pattern 18 inches wide and 9 inches long,

Therefore $\dfrac{96 \times 9}{36} = 24$ yards of carpet 18 inches wide.

Example II.

A rug design which wields or turns over is to be woven 3×6 feet with $3\frac{1}{2}$ shots of fur chain per inch. Find the length of each strip of fur required to be made in the chenille loom and the number of strips required to produce 30 rugs.

Since the unit length of the design is equal to 1 yard and the width is the same.

Then, the number of yards of fur required for each unit pattern or half rug is just equal to the number of shots of fur in one yard of woven rug.

Thus $3\frac{1}{2} \times 36 = 126$ yards of fur.

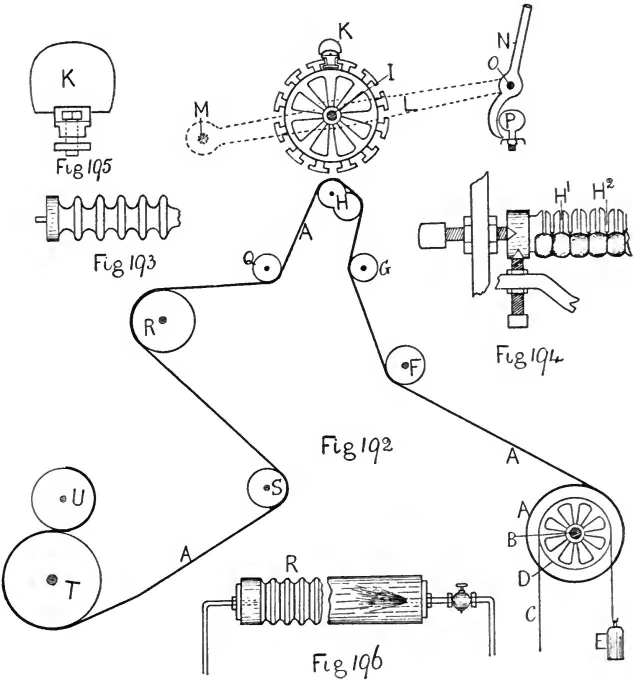
The second half of the rug can be produced by the next duplicate strip of fur but commencing with the opposite end; consequently two strips of fur are required for each rug and the number of duplicate strips which must be woven together will be 60; the width of these in the reed will depend upon the 'depth' of the fur, 33 inches being a general and suitable width.

Cutting the chenille piece into strips and formation of the fur.

The method adopted in cutting the chenille woven texture into strips and of its simultaneous conversion into fur by folding and steaming is illustrated from Figs. 192 to 196 inclusive. Fig. 192 represents a vertical section through the fur cutting and folding machine. This diagram reveals all the essential parts of the mechanism, but the most important are separately illustrated and described.

The piece to be cut is tightly wrapped in the open width on to a tin cylinder or 'can' during its process of weaving; the inside of this 'can' contains a projection which just fits into a groove formed in the full length of a wooden roller or piece beam B which is placed between suitable supports; a leather strap C is passed over the brake pulley D; one end of the strap is securely fastened to the frame work while the other supports a heavy weight E which serves to sufficiently resist the tension exerted by the pull of the piece in its forward movement. The fabric then passes under a fluted or contracting roller F, the purpose of which is to 'gather in' the piece to its proper width preparatory to the cutting process. A plan of this roller is supplied at Fig. 193. The piece then passes under a wire card or perforated tin tension roller G which grips it firmly and holds it tightly whilst passing over the adjustable cutting bed H which is shown separately at Fig. 194. The upper surface of the bed is made of steel, is corrugated in shape and smooth in appearance; the higher projections H^1 have a small slit or division into which a knife can enter. The piece is so set on it, that the centres of the *uninterlaced* yarn will pass over the slits H^1 while the binding threads fall into recessed divisions H^2. A drum I is supported and free to revolve in the arm of the lever L as shown. This wheel which is called the cutting drum contains 12 divisions into which may be inserted an equal number of very

sharp cutting knives K, one of which is shown separately at Fig. 195. The lever L is capable of being elevated or depressed at will, so as to either lift the cutting drum I and the knives K clear of the piece or allow them to fall so that the blades pierce the cloth, and enter the



Figs. 192 to 196.

slits H^1 in the bed H. Consequently as the drum I is made to revolve and the piece A to pass simultaneously over the cutting bed H, the knives K travelling with considerable rapidity cut the cloth into the *required strips* of fur. If anything goes wrong during the

action of cutting, the forward movement of the piece can be automatically arrested so that the cutting blades though still continuing to revolve, do no more actual cutting until the remedy is applied.

These strips now pass under a second card roller Q and forward to a hot roller R which is grooved and called the closing roller. The function of this roller which is full of steam is to close up the fur and so impart to it permanence of shape. Fig. 196 shows a front view of the roller R.

These closed strips then travel on their sides around the wooden roller S to the card roller T and finally each strip is wound around the roller U. Each strip of fur is then numbered for the convenience of the carpet weaver.

Weaving the Rug or Carpet.

The fur chain already prepared and woven to the desired pattern is laid across a strong and coarse foundation textile structure. It is bound on the surface of this base structure during the process of weaving by fine yet very strong threads of cotton or linen, generally called 'catcher' threads.

For a long period after the introduction of patent Axminster, the only successful method of introducing the chenille fur was to wrap it on a stick, which served the purpose of a shuttle and then pass it through the shed by hand under the binder or catcher warp threads. Many attempts have since been made especially of recent years to lift the catcher or binder warp threads clear of the usual warp out and above the reed, these being the only threads which pass over the fur in the actual carpet or rug. The fur chain is then laid automatically and transversely above the warp belonging to the base structure but under the binder threads. The first attempt was made by a certain John Orr. Subsequently Messrs. Hutchinson and Hollingworth of Dobcross, Mr. A. Stubbs (Messrs. Sheard & Co.) Halifax and others have each introduced improvements, which in many respects dissimilar, nevertheless successfully produce these rugs and carpets by power and to see these mechanisms performing their work is not only deeply interesting but very inspiring to any student who possesses originality and appreciative abilities.

But since the 'hand method' is still practised a brief description of the processes and essential principles of weaving is included which will also serve as an introduction to the automatic method and tend to give a clear conception of the rug or carpet structure and method of manufacture.

Structures and Makes of Rugs and Carpets.

Prior to any full description of the actual method of weaving, a complete understanding of the weave structure and makes of such rugs and carpets will be found helpful.

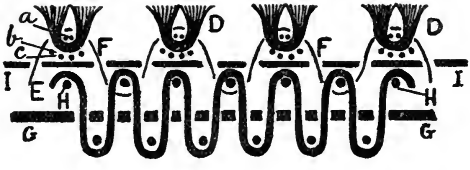


Fig 197

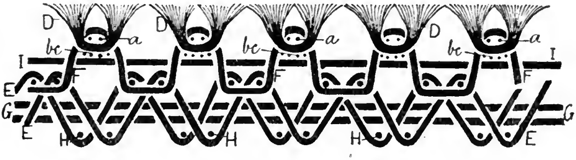


Fig. 198.

Chenille Axminster carpets and rugs are made with two chief kinds of backs.

First, the 'single shed' tapestry or carpet back.

Second, the 'double shed' or rug back.

The former produces a light and the latter a heavy back. In each of these carpets a 'float' warp is frequently introduced between the fur and the base structure which serves to increase its weight as well as to make the fur stand up better.

The structures of these completed carpets are illustrated by transverse sections through the fur and weft at Figs. 197 and 198.

The former represents a tapestry back and the latter a rug or heavy back, with float and two stuffers.

E represents the small chain or ground warp of the base structure.

G the stuffer warp.

I the float warp.

F the fine chain which binds the fur to the base structure.

H the carpet filling weft.

D the fur chain.

a b c the warps or chain belonging to the fur.

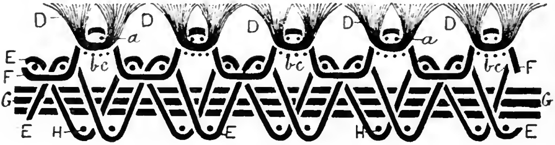


Fig. 199.

Fig. 199 shows a transverse section through the filling and fur of a rug back, which contains three stuffers but no float. The letters refer to corresponding threads as in the foregoing two figures.

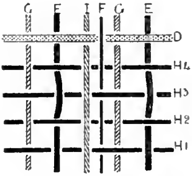


Fig. 200.

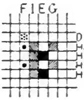


Fig. 203.

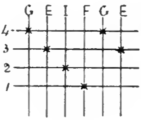


Fig. 202.

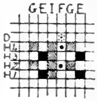


Fig. 201.

A plan view of the carpet—single shed—on an enlarged scale is supplied at Fig. 200. A complete paper design for same at Fig. 201. (Marks in all cases indicate the warp threads up.) A drafting plan of the warp threads through the healds is given at Fig. 202, and a treading plan for this draft required to produce the fabric structure of Fig. 200 is shown at Fig 203.

The transverse lines represent the heald shafts and the longitudinal lines the warp threads. In order to work the pattern it will be noticed that four healds are required through which the warp threads are drawn as follows :—

For a carpet or rug with carpet back—single shed.

1	Thread	G	Jute Stuffer (16-lbs. Aberdeen)	drawn through mail on shaft 4	1 Dent
1	,,	E	,, Ground (15-lbs ,,)	,, ,, ,, ,, 3	
1	,,	I	,, Float (3/7 Cotton)	,, ,, ,, ,, 2	
1	,,	F	,, Fine chain (2/24 Cotton)	,, ,, ,, ,, 1	
1	,,	G	,, Stuffer	,, ,, ,, ,, 4	1 Dent
1	,,	E	,, Ground	,, ,, ,, ,, 3	

6 Threads to each repeat of the draft.

These threads are sleyed into two splits in the reed as indicated and repeated until the whole of the warp is sleyed which extends to 36 inches in the reed and contains 7 splits per inch.

Filling 4 shots of 2/7½ orange coloured jute.

1 ,, ,, fur chain.

Containing 16 shots of weft and 4 of fur chain per inch.

When carpets have to be made with 5 to 8 shots of fur per inch, it is usual to insert *two shots* of filling to each shot of fur.

Reverting to the structure plan Fig. 200 the *first* tread requires ground threads E E and float I to be raised and since these are drawn on to shafts 3 and 2 these shafts are lifted as indicated by the markings on the first pick of the treading plan Fig. 203.

On the *second* tread, stuffer threads G G, fine chain F and float I require to be raised and since these are drawn on to shafts 4, 2 and 1, they are accordingly indicated to be lifted.

The *third* tread is an exact repeat of the first and the *fourth* of the second.

On the *fifth* tread, the binding thread F is only required to be raised and since this is drawn on to shaft 1, it being the only shaft marked for lifting on this pick, the weaver treads five picks for each successive repeat of the weave structure and inserts four successive picks of filling into the ground sheds, but into the fifth he introduces one shot of fur, which he tightens or slackens so as to make the outline of the pattern on it coincide with the

portion of pattern already woven. Each fur pick is combed towards the fell of the carpet and straightened before beating up, preparatory to forming the next shed of ground. The fur is contained on a stick which serves the purpose of a shuttle or "sword;" usually there are about 20 shots of fur on each stick; these have of course been previously numbered so as to correspond with the picks or strip numbers on the figure design paper, consequently it is easy for the weaver to match the design.

Each warp has to be wound on a separate beam because the take up of each is different. The beams are suitably arranged to the back of the loom framing, the tension is regulated by friction, the ordinary twitch rope lever and weight being the chief factors.

The take up of the cloth is also on the negative principle and of common construction.

Rug Structure 'Double Shed.' Particulars of make and structure for a rug back—double shed.

First Warp.—Binding thread once in every *three* dents.

1 Thread	G stuffer 6/9 lbs. per spindle = 54 lbs. per spindle	hemp—	heald 5	1 Dent
1 ,,	E ground 2/8 lbs. per spindle	jute—	,, 4	
1 ,,	I float 2/7½ ,, ,, ...	jute—	,, 2	
1 ,,	F fine 4/24	cotton—	,, 1	
1 Thread	G stufter		heald 5	1 Dent.
1 ,,	E^1 ground		,, 3	
1 ,,	G stuffer		,, 5	1 Dent.
1 ,,	E ground		,, 2	
1 Thread	G stuffer		heald 5	1 Dent.
1 ,,	E^1 ground		,, 3	
1 ,,	I float		,, 2	
1 ,,	F fine chain		,, 1	
1 ,,	G stuffer		,, 5	1 Dent,
1 ,,	E ground		,, 4	
1 ,,	G float		,, 5	1 Dent.
1 ,,	E^1 ground		,, 3	

16 Threads in each repeat of pattern which are sleyed into 6 dents as indicated.

Filling—4 shots of ground 4/7½ Jute.
1 ,, fur chain.

Containing 14 picks of ground per unit and 3½ shots of fur.

A plan view showing two repeats (on an enlarged scale) of such a rug is supplied at Fig. 204, a full point paper design for same at Fig. 205, a drawing-in or heald plan at Fig. 206, and a treading plan at Fig. 207.

Second Warp.—Binding once in every *two* dents.

Warps.	1 thread	G stuffer	6/9 lbs. per spindle		1 dent.
	1 ,,	E ground	2/8 ,, ,,		
	1 ,,	I float	$2/7\frac{1}{2}$,, ,,		
	1 ,,	F fine chain	4/24 cotton		
	1 ,,	G stuffer	6/9 lbs. per spindle		1 dent.
	1 ,,	E^1 ground	2/8 ,, ,,		

6 threads in each repeat of plan.

Weft. 4 shots of ground $4/7\frac{1}{2}$ lbs per spindle.
1 ,, ,, fur chain
Containing $3\frac{1}{2}$ shots of fur per inch.

Fig. 208.

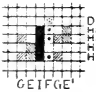


Fig. 205.

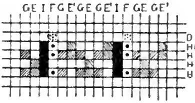
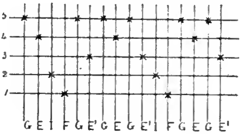


Fig. 206.



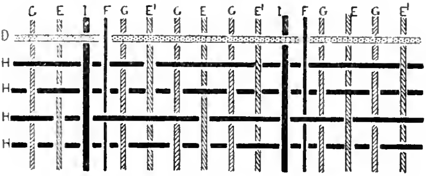


Fig. 204.

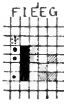


Fig. 207.

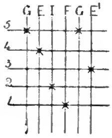


Fig. 209.

The first six threads on the left hand of the plan view given at Fig. 204 represent one repeat of the above carpet. The complete design on point paper is supplied at Fig. 208, the draft at Fig. 209 and the treading plan at Fig. 207. The chief points for consideration in the structure of these two cloths are :—

1. They each contain two picks in one ground shed with a stuffer warp lying perfectly straight between the bottom and the top shots of weft.
2. The ground threads bend equally and consequently they may both be placed on the same warp beam.
3. There is a float warp in each carpet.
4. The binding thread is the only point of dissimilarity. This is noticeable only by comparing the respective plan views, drafts and full designs. In the first warp the binding thread occurs once every two splits of 6 threads and in the second warp once in every three splits of 8 threads.

The carpet is woven in the same kind of loom and the fur is inserted by hand but the treading plan is altered to suit the different textile structure.

Automatically Inserting the Chenille Fur.

The recent introduction and perfecting of power looms for weaving Chenille Axminster carpets has considerably increased the output.

Three yards can now be woven on these looms whilst one yard is being woven by the original hand loom method which is still in use.

A perspective view of one of these power looms is supplied at Fig. 210, the chief features of which are as follows:—A specially constructed reed without any top or hand rail is shown at *a;* this reed is very strong and in sections. The base of each individual reed is securely fastened into a brass bed; usually every three reeds are fastened together by filling in solid the tops of two dents out of every three. They are tapered at the tops so as to leave an opening and to facilitate the entrance into every third split of the catcher or binder warp threads *b*, which are passed through the eyes of the needles *c*, these last being operated upon according to the requirements of the shed and binding of the fur. The needles are set to the required fineness and pitch of the reed and are contained on and depend from a needle bar *d* which stretches across and above the warps at the front of the loom; this bar is supported

at each end in a frame which is free to travel upwards or downwards as desired. The needles are pointed at their lower ends so that they may readily enter between the warp threads of adjoining splits in the reed according to the structure. The binding warp threads are contained on the beam roller *g* supported in the frame *e* from which they pass over and in front of a tension roller *f*, also in frame *e*, then

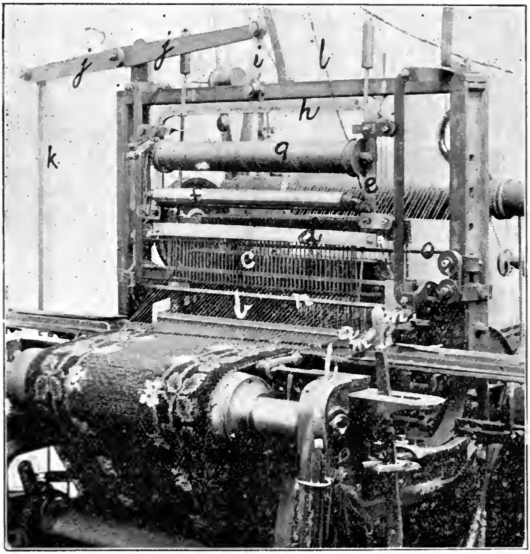


Fig. 210.

backwards and over a roller bar immediately behind and parallel with *f*, from whence they are passed downwards to and through the eyes of needles *c*. The frame *e* is suspended between two vertically fixed slide supports; antifriction rollers are secured in suitable brackets of the frame *e* and press against the vertical slide supports as shown and thereby reduce the friction to a minimum. The two

sides of the frames are joined by a cross bar *h*; a connecting link *i* unites this bar *h* with a jack lever *j* pivoted as shown in the illustration; the lever *j* receives its rising and falling motion from a positive tappet on the low shaft operating upon a bowl and treadle lever which is joined to the jack lever *j* through the connecting rod *k*. The chenille fur *l* is generally contained in a basket or can, from which it travels over suitable guide rods to and through a specially grooved guide finger *m*, made from hard wood or steel. The fur guide or 'carrier' *m* is supported and free to slide in a lateral direction along two smooth spindle rods *n* and n^1 which stretch across the loom, above and just behind the lay of the going part, being suitably fixed to the two slide supports of the frame *e*. The fur carrier projects over the reed to a point near the fell of the carpet. An endless rope *o* is fixed to both sides of the bracket which holds the fur carrier; this rope passes around suitable pulleys to a large wooden pulley at the left hand side of the loom—part of this pulley is visible in the illustration. It is made to rotate backwards and forwards and by this means impart the necessary to and fro motion to the fur carrier *m*. The rotary action of the rope pulley is obtained from the combination of a lever rack and pinion; the pinion and the rope pulley are both secured to a short shaft carried in brackets projecting from the frame work; the pinion rack is acted upon by a cam on a counter shaft driven from the bottom shaft and at half its speed. The driving mechanism is compounded so as to detach and arrest the parts which control the reciprocating action of the lay of the going part.

Timing of the movements in relation to each other.

The various movements in a power loom for weaving 'Chenille' Axminster Carpets may be summarised and described as follows:—Example: Assume a carpet has to be woven with *two* shots of filling 'single shed' to *one* row of fur. Then, measuring the time from the bottom shaft, which is continually running and revolving at the rate of one-fifth the velocity ratio of the crank shaft, one-fifth of a revolution of the bottom shaft is made during the insertion and beating up of *each* shot of ground filling; the remaining three-fifths of the revolution is occupied in

laying and setting the fur. There are several devices adopted to impart the reciprocating movement in the lay of the going part; some utilise the cam action, others drive from the crank shaft which method is to be preferred since it is possible to obtain a more uniform beat and to run at a higher rate of speed if necessary. In addition to the needle frame previously mentioned there are two heald shafts one for the ground and one for the stuffer warp. The former heald is *up* and the latter *down* at the moment the lay is starting to beat up after an interval of rest during the insertion of the fur. In the forward movement of the lay these two shafts begin to reverse their positions, so that on the lay's return the ground chain is up and the stuffer heald down. The first pick of ground weft is then inserted after which the lay moves forward to beat this shot of weft into the fabric. On the second pick the stuffer heald is up and the ground chain down. In this position the lay rests full back with the shot of weft in the open shed whilst the fur carrier conveys a shot or length of fur across. The weaver places the same in position, the needle frame falls with the binding warp over the fur and the lay again begins to beat up. These operations are repeated until the required length has been woven.

Special form of Reed.

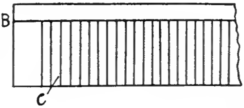
Fig. 211 shows a front view of a portion of the reed, Fig. 212 a side view of the same, and Fig. 213 a plan of the base. The reed A is made of hardened steel and has a brass foundation B; small divisions C are cut with a saw into the base and the lower ends of the individual reeds are respectively inserted into these spaces and fastened with brass soldering. The middle reed in each set of three projects somewhat at the back as shown at D in Fig. 212 for the purpose of adding strength to the reed. The whole is supported on two vertical rods, one at each end, which are free to be lifted as desired by cams operated from the bottom shaft. The full reed is lifted slightly with each forward movement of the lay of the going part, the object being to partially comb the fur and cause it to stand up better.

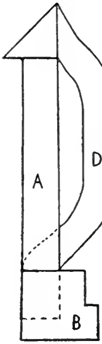
Needles and Frame.

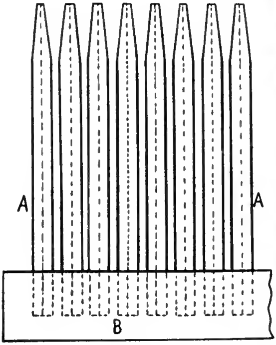
A portion of the needle bar and needles, is shown at Fig. 214. The bar is indicated at E, the needles at F, and the eye of the needle through which the

catcher warp *b* passes at G. The needle bar is fixed to the needle frame at H.

Fig 213







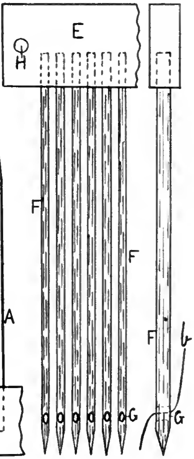


Fig. 212. Fig. 211. Fig. 214.

Fur Carrier.

A side view of the fur carrier, bracket and the rods on which it slides is supplied at Fig. 215. The carrier *m* is suitably grooved in spiral form to

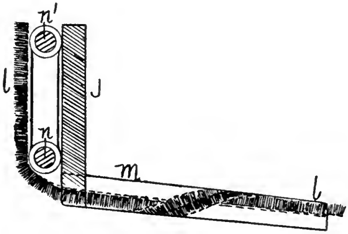


Fig. 215.

serve as a guide for the fur; the bracket to which it is fixed is shown at J, the slide bars at *n* and n^1 and a portion of the fur at *l*.

Intermittingly Driving the "Lay," and the Fur Carrier.

Messrs. Tillotsons and Stubbs' patented method of performing these functions is briefly indicated at Fig. 216 which represents a back elevation of the essential parts. The crank or main driving shaft is shown at 1 and is suitably supported in the

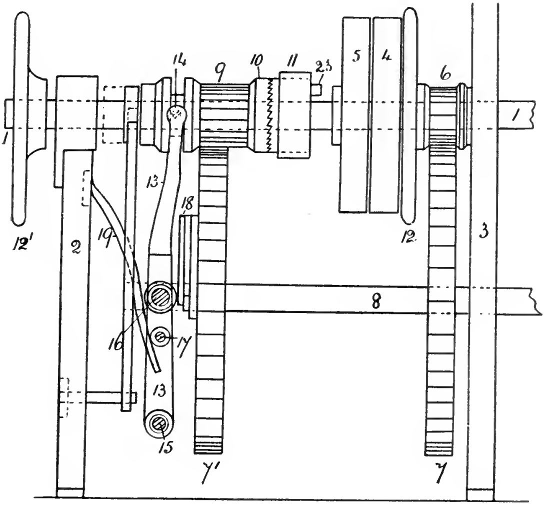


Fig. 216.

framework of the loom at 2 and 3. Two loose pulleys 4 and 5 are placed upon this shaft and free to revolve; compounded with the boss of pulley 4 is a pinion wheel 6 which meshes with the teeth of a large spur wheel 7 securely keyed to the low shaft 8 and called the cam shaft. Upon shaft 8 a spur wheel 7^1 similar to that of 7 is secured and gears into and drives a small spur wheel 9 which is fast

or cast upon the boss of a sliding clutch wheel 10 also loose upon the crank shaft 1. This clutch is free to engage with the teeth of a second clutch 11 fast to the crank shaft. A connecting link joins the crank shaft to the sword of the going part; 12 is a hand and 12^1 a balance wheel. The forked end of a lever 13 fits into the neck 14 of clutch 10; this lever is pivoted and free to rock on a stud shaft 15. Two antifriction bowls 16 and 17 are placed on suitable studs in this lever. The former bowl 16 is kept in rolling contact with a suitably shaped cam 18 secured to the boss of spur wheel 7^1; a strong blade spring 19 operates constantly upon the second bowl 17 to keep the lever 13 against the face of the tappet 18 and also as the pressure of the cam is released to move the pinion wheel 9 and clutch 10 on shaft 1 into gear with the second clutch 11.

Minor details are added to hold the pinion 9 and clutch 10 in gear with clutch 11 when necessary.

Simultaneously with the detachment of the clutches, a double clamp grips the boss of clutch 11 and a lever rod having a hook at its free end is designed to lay hold of the peg 23 projecting from the clutch box 11 and thereby prevent any further movement of the crank shaft 1 until the fur has been inserted and is ready to be beaten up into the carpet.

The 'Picking' in most of these looms is preferably obtained from the crank shaft, designed as is common so that the striking hammers fixed on rotating picking wheels, one at each side of the loom, alternately hit and miss the tongues secured through the usual connections to the picking stick.

An Alternative Method.

The plan adopted by Messrs. Hutchinson and Hollingworth for driving the lay intermittingly and also for inserting the fur is briefly described and illustrated as follows :—

Fig. 217 represents a back elevation of the method of driving and automatically arresting the rotary action of the crank shaft.

Fig. 218 shows a similar view for driving the fur carrier.

Fig. 219 is a plan view of both.

A perspective view of this loom is supplied at the end of the book.

Driving the "Lay."

Rotary motion is imparted to the fast and loose pulleys A and B respectively on a cross shaft C to which is also fastened a small bevel wheel D; the teeth of D gear into those of a larger bevel wheel E loosely mounted on the crank shaft F. Compounded with the sleeve F^1 or barrel of the bevel E is one half of a clutch box G; the second half which is shown at H is secured to the crank shaft F, but free to move laterally along it by means of a fork lever I; the stud of fork I is operated upon by the free arm of a lever I^2 centred upon a stud J carried in a bracket suitably secured to the framework. The lower arm of the lever I^2 carries a bowl K which is kept in rolling contact with a cam L by means of a strong spiral spring M which joins the fork end of lever I^2 to the loom supports. The cam L is mounted on a counter shaft N supported in the framework; at the opposite end of this shaft is fastened an octagonal star wheel O which receives rotary intermittent motion through the contact of peg P fixed in and projecting from the bevel wheel E.

Driving the Fur Carrier.

A pinion wheel Q is secured to the sleeve F^1 of bevel E and gears into a spur wheel R twice its size and loose upon the stud shaft S supported in the framework; the boss of spur wheel R contains a small pin hole T^3 into which a clutch pin T projecting from the clutch T^1 is free to enter.

A lever U centred at U^1 is forked at one end and fits into the neck T^2 of clutch T^1; the lever carries an antifriction bowl U^3 which is kept in rolling contact with a tappet U^4 mounted on shaft N. A spiral spring U^5 joins the forked end of lever U to the framework and thereby tends to keep the bowl U^3 in lever U continuously against the face of the tappet U^4. Secured to the shaft S remote from spur wheel R is a small crank arm V which rotates intermittingly with the shaft S; a connecting rod W joins the crank V with a second crank V^1 fastened to the shaft X; this shaft carries a segment wheel V^3 having spur teeth which gear into a small pinion wheel Y secured to the shaft Z mounted upon which is a pulley Z^1. An endless cord Z^2 passes over this pulley and its duplicate at the opposite side of the loom, to both sides of the bracket Z^3 containing the fur carrier; pulley Z^1 is thus free to impart the required reciprocating motion in the fur carrier.

Action of the Mechanism.

The combined action of the foregoing mechanism for intermittingly driving the lay and the fur carrier is as follows:—

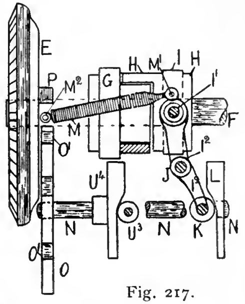


Fig. 217.

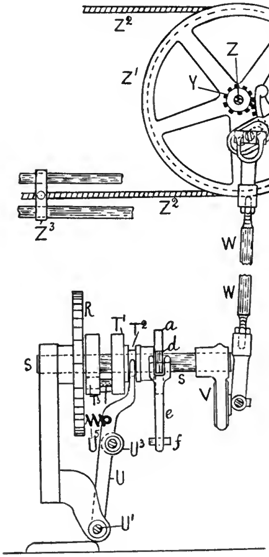


Fig. 218.

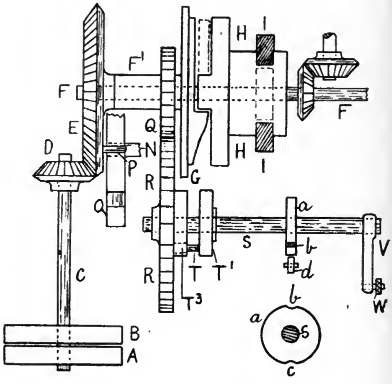


Fig. 219.

Fig. 220.

The shaft C receives a constant rotary motion when the driving belt is on the fast pulley; the bevel D in turn rotates the bevel E, compounded with sleeve F^1, pinion Q and clutch box G all independently of the crank shaft F, whenever the raised face of tappet L on shaft N is pressing against the bowl K in the lower arm of lever I^2 which thus partially rotates this lever clockwise so that its upper

arm operating through the stud I^1 and fork I moves and holds clutch H clear of clutch G. Meanwhile the peg D at the back of bevel E continuing to revolve enters one of the notched recesses O^1 in the star wheel O so as to rotate the shaft N one eighth of a revolution or more according to the requirements of the carpet structure. The partial rotation of shaft N causes tappet L to release its pressure upon the bowl K and lever I^2, thus permitting the spiral spring M to pull clutch H into engagement and lock it with clutch G which being in constant rotation also turns clutch H and shaft F in sympathy with it. The crank shaft operating through its usual connections imparts the to and fro movements to the 'lay' and beats up the weft or fur into the carpet.

Acting in concert with the foregoing, the pinion Q drives the spur wheel R at half the speed of crank shaft F, continuously and independently of the counter shaft S whenever the clutch pin T of clutch T^1 is held clear of the pin hole T^3 in the boss of wheel R, through the pressure of the projecting face of tappet U^4 on the bowl U^3 and lever U the free end of which acts in the neck T^2 of clutch T^1. But with the partial rotation of shaft N tappet U^4 releases its pressure on bowl U^3 and lever U, thereby permitting the spiral spring U^5 fastened to the framework and the lever U to pull the latter against the left side of the neck T^2 and so move pin T into the pin hole T^3 which thus locks clutch T^1 and shaft S rotatively with wheel R. Then with the rotation of shaft S, the crank V revolves and imparts a reciprocating movement to the rod W, lever arm V^1, shaft X, arm V^3, pinion Y, shaft Z, pulley Z^1, and rope Z^2 which last, being attached to the fur carrier bracket, also produces in it the required to and fro movement.

Any tendency of the shaft S to over-run itself is obviated by the constant pressure from a bowl *d* on disc *a*; this bowl is supported in the free end of an upright lever *e* pivoted on the stud *f* fixed in the framework of the loom. The disc *a* has two indents *b* and *c* diametrically opposite to each other, see Fig. 220. The runner *d* is adapted to enter one of these recesses on each half revolution of the shaft S and thereby hold it firmly in position until the clutch pin T is disengaged from the boss of spur wheel R.

CHAPTER IX.

Kidderminster and Scotch or Ingrain Carpets.

KIDDERMINSTER, Scotch and Ingrain are synonymous terms for the same carpets which were originally made at Kidderminster in England and subsequently very extensively in Scotland and also in U.S.A. where they are chiefly designated 'Ingrain.'

They differ widely from all the carpets previously described in this treatise which are all corded or velvet pile structures, whereas these belong to the general or non-pile class of woven fabrics.

The original and simplest kind consisted of a two-ply fabric usually double plain and woven with the aid of a double cloth jacquard, in such a way as to produce the same figured pattern on both sides of the carpet though in different colours; this was accomplished by causing the two sets of coloured threads to change places which at the same time fastened the fabrics together.

The original structure has been modified to such an extent that it is now nearly impossible to recognise any resemblance between it and the present Ingrain.

The carpets are sometimes woven in 4/4 width but a very considerable proportion are produced in squares of three by three yards and denominated, "Art Squares." They are woven in a loom fitted up with a jacquard machine and a full harness mounting and in many cases a cross border jacquard is used but whichever method is adopted, arrangements are usually made for fixing and working from two to eight shafts in combination with the harness which shafts then carry special binding threads referred to later.

The numerous structural varieties will be comprised under one or other of the following divisions.

Type I. Two-ply in the warp and weft, usually double plain, of which Fig. 221 is an example.

The warps are arranged :—

1 thread A. Red worsted 2/4s. 5 turns per inch.
1 ,, B. Olive ,, ,, ,, ,, ,, .

Sett 24 threads per inch in the loom.

Weft threads X and Y—shades as warp—24 picks per inch.

Fig. 221.

Type II. Two-ply warp and weft as at Fig. 222 but the warps and wefts comprising this structure are arranged as follows :—

Warps. 1 thread A. 2/10 Black Worsted.
B. ,, Red ,,
C. ,, White ,,
D. ,, Yellow Olive Worsted.

Woven 14 splits per inch and 2 in a split.

Fig. 222.

Wefts.

1 pick W. Black Worsted 1/15 lbs. per spindle or 1⅔ worsted—4½ turns per inch.
1 ,, X. Red ,, ,, ,, ,, ,, ,, ,, ,, ,, ,,
1 ,, Y. White ,, ,, ,, ,, ,, ,, ,, ,, ,, ,,
1 ,, Z. Yellow Olive Worsted ,, ,, ,, ,, ,, ,, ,, ,,

The foregoing particulars afford many possible combinations of colour on the surface of the carpet of which the following are a few :—

1. Black and red warp with black and red weft.
2. ,, ,, white ,, ,, ,, ,, white ,,
3. ,, ,, olive ,, ,, ,, ,, Olive ,,
4. Red ,, white ,, ,, red ,, white ,,
5. ,, ,, olive ,, ,, ,, ,, olive ,,
6. Olive ,, white ,, ,, olive ,, white ,,

But these do not limit the possible number of combinations, *e.g.* The first line of warps 1 may be associated with that of line 2 of the weft, etc., though these additional effects can only be obtained where a full harness is employed. A reference to the figure shows that each colour of weft crosses over its own colour of warp on the surface, but when the two cloths change places, if woven on a *double-cloth* jacquard machine, the colours of warp and

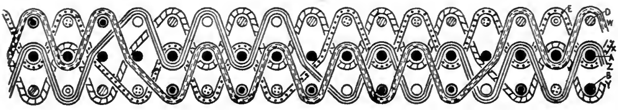


Fig. 223.

weft on the underside of the fabric are crossed, which may be an advantage in some few cases, but since unavoidable, it is a limitation which is considered one of the defects of producing these fabrics with the aid of a double cloth jacquard.

Type III. Three-ply warp and two-ply weft as illustrated at Fig. 223 which represents a transverse section through the warp. In this example the additional or third warp consists of a thick stuffer thread A, which not only serves to increase the weight of the

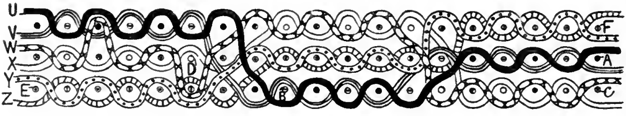


Fig. 224

fabric, but also offers a favourable opportunity to bind the two cloths together ; such a fabric is most conveniently produced with a full harness mounting. The warps A, B, C, D and E are respectively dyed black, red, green, straw and red and green twist ; the wefts W, X, Y and Z respectively agree with the shades B, C, D and E.

Type IV. Three-ply warp and weft as shown by the transverse section through the warp at Fig. 224. The differently coloured warp

and weft threads are indicated at A, B, C, D, E and F and U, V, W, X, Y and Z. The figure is produced by crossing the fabrics and colours as shown, by which means the three structures are also fastened to each other at the points of interchange. But wherever there is a considerable area of one effect, the cloth is not fastened and hence it appears loose and open. To avoid this, one of the threads of warp or weft is sometimes used as a binding thread to hold the fabric more firmly together as is clearly seen if the interlacing of the weft thread W is traced out.

Fig. 225.

Roman Carpets. Type V. Fig. 225 shows a cross section through the warp of an Ingrain carpet which is sometimes designated "Roman." This idea of interlacing has evidently been borrowed from a method which is common in tapestry work. The term tapestry here is used in its widest sense and as applied to decorative fabrics. There are two warps and three wefts but any number of wefts within reason can be employed, say 4 or 5, but each additional weft and colour increases proportionately the cost of the fabric though it simultaneously increases the weight. The warp G is a thick stuffer thread which may consist of cotton, jute or any cheap but strong textile yarn. A strong but fine cotton binding warp thread H is employed for the purpose of binding the filling threads down. In this example there are three differently coloured weft threads X Y Z and these produce the figure. The designs are drawn and coloured to any convenient scale without the addition of any weave development. A section of such a design is illustrated at Fig. 226. The three different markings represent three distinct colours. The warp threads are wrapped on separate beams and arranged 1 thread G and 1 thread H or 2 threads G and 1 thread H. A full harness mounting controls all the threads G but the binding threads are drawn through two or four heald shafts according to the fineness of the set. These may be con-

trolled either from a set of tappets contained on the bottom shaft or acted upon direct from the jacquard machine. As an alternative method two or four rows of harness cords are tied up in front or behind the harness and worked directly from the jacquard, specially constructed and strong upright hooks being always used when this plan is adopted.

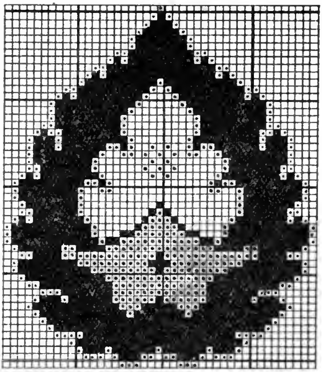


Fig. 226.

In these cloths the effects of colour are not confined exclusively to three, even when three differently coloured wefts only are employed *e.g.* Assuming the colours to be black, red and olive, the following effects may be produced on the surface. 1. black; 2. red; 3. olive; 4. black and red; 5. black and olive; 6. red and olive; in addition to the foregoing, gradation from any of these colours into each other may very effectively be obtained.

Card Cutting Instructions.

Three jacquard cards are required for each horizontal row across the point paper design or as many cards as there are colours of weft; then for the three colours, black, red and olive, each pick must be cut three times, viz :—

I. For each horizontal odd row of colour on the design paper, lift heald number 1, which must remain up until all the colours have been woven over once.

Card 1. B. Cut all except black and insert one pick of black weft.

Card 1. R. Cut all except red and insert red weft.

Card 1. O. Cut all except olive and insert olive weft.

II. For each horizontal even row of colour in the design paper lift heald number 2 and cut cards 2 B, 2 R and 2 O, exactly as above.

Type VI. Fig. 227 shows a cross section through the warp of a carpet where the ground of the pattern is produced in *plain* weave; the additional figure is obtained by the wefts in exactly the same way as in the previous structure, the middle warp being

Fig. 227.

of better quality. The warps are dressed on separate beams and arranged

1 thread A. 2/8 worsted for ground.

1 ,, B. 3/24 cotton ,, binding.

Set 10 splits per inch containing 2 threads A and an equal number of threads B in each split.

Wefts.

1 pick X. 2/8 worsted.

1 ,, Y. 2s ,,

1 ,, Z. 2s ,,

Woven 60 picks per inch.

Note:—Types of cloth as I and II can be conveniently, economically and frequently are woven on a double cloth jacquard; cloths III, IV, V and VI require a full harness mounting and for types V and VI the addition of 2 to 8 heald shafts.

One of the best methods of employing a double cloth jacquard is separately and fully illustrated and described as follows:—

Double Cloth Jacquard and Compound Harness Mounting.

This style of mechanism is introduced for the purpose of effecting economy in designing and the saving of cards in cutting as well as increasing the capacity of the machine without a corresponding increase of needles. A transverse section through the comberboards, card cylinder and spring box, which affords a view of an elevation of one row of needles and uprights together with the

system of harness mounting, is illustrated at Fig. 228. The card cylinder is shown at A, the needle board at B, the needles or cross wires at C and the spring box at D. There are two sets of uprights E and F to each of which there is a separate griffe G and H, which carry knives I and J respectively. The uprights rest upon cross bars fixed as is common in the stationary board K. The uprights E are set directly opposite those of F. The hooks of the former are normally over the knives when the latter, in their natural position, are clear.

The needles c^1 c^2 c^3 and c^4 are respectively linked to uprights F^1 and E^5, F^2 and E^6, F^3 and E^7, and F^4 and E^8 as shown. The comberboard is in four longitudinal sections I, II, III and IV; these are suitably connected to a set of tappets placed at and worked from the end of the loom. Each section is free to be lifted or depressed independently according to the cloth structure. When weaving double plain cloth, combined with the harness for figuring, each board is elevated once in every four picks. The harness cords from the uprights F are passed alternately through the first and second comberboards and from the uprights E they are passed alternately through the third and fourth comberboards.

The warp threads are arranged, say, 1 red, 1 olive or each colour may be dressed on a separate warp beam; these threads are drafted through the harness so that the first board commands all the odd numbered and the second board all the even numbered threads of red, whilst boards III and IV similarly control the olive threads. The harness cords are knotted just above the comberboard for the purpose of lifting them as required. The plan of the divided comberboard is shown at Fig. 229. There are two rows of holes across the length of each board, numbered consecutively R 1 to R 8. The draft of the warp threads through the mails of the harness below these boards is shown at Fig. 230. The warp threads are consecutively numbered from 1 to 8 and the row in the comberboard with which each is connected is indicated from R 1 to R 8. The hooks to be lifted for each shed are regulated by perforated cards being pressed against the points of the needles. A perforation in the card allows the point of a needle to pass through. Consequently

whenever the needles are pressed inwards to the right by an unperforated jacquard card, the uprights E are pressed clear of the knives I but the uprights F are moved into position immediately above the

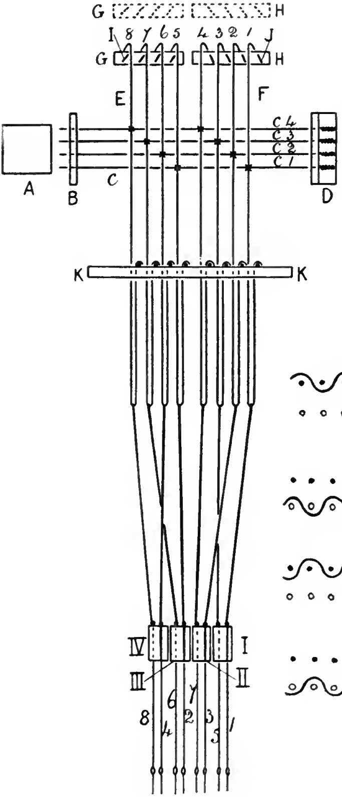


Fig. 228.

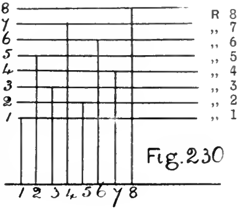


Fig. 230

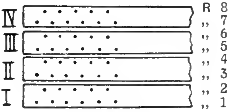


Fig. 229.

Fig. 231

Fig. 232

Fig. 233

Fig 234

knives J so that with the elevation of the griffe H all the uprights F will be lifted together with their harness cords, mails and warp

threads; conversely, a fully perforated card allows the points of the needles to pass through and the hooks E to be raised while those of F are left down. Hence, between an unperforated and a fully perforated jacquard card any variety of shedding can be produced by suitably punching the cards.

The two griffes rise and fall on alternate picks. The cylinder strikes once in every two picks and is kept against the needles until each griffe has had sufficient time to catch the hooks which have been selected for lifting *e.g.* For every hole in the card presented by the cylinder to the needles the corresponding hook in portion E will be caught by the griffe bars G and lifted up. When the griffe H is up that of G is down and since the hooks E are set opposite those of F then the blank places of the card will push corresponding hooks F over the griffe bars H so that on the next pick they will be lifted.

With the foregoing arrangement of parts all the red threads will be raised by lifting the hooks F and all the olive threads by lifting the hooks E. By leaving all the hooks down and lifting boards I and II alternately and inserting red weft, a plain red weave will be produced on the surface of the carpet and by lifting boards III and IV and inserting olive weft, an olive surface will be the result.

If some portion of red mounting is lifted with an 'olive board and olive weft inserted, red will appear on the surface where hooks are lifted and olive at the back, but where there are no hooks lifted, the reverse will be the result, viz:—Olive on the surface and red on the back.

The opposite of all this will take place if some portion of olive mounting is lifted with a red board and red weft is thrown in. Thus all the jacquard does is to lift red warp above olive weft, where red is to show on the face of the cloth and vice versa. These possibilities form the basis of designing for all such mounting. The comberboard produces the cloth while the jacquard machine forms the figure, therefore in designing it is only necessary to paint the figure on point paper and cut the cards from it, no weave development being required.

Card Cutting Instructions. Two jacquard cards and four picks of weft are required for each repeat of the weave structure. Card 1. *First pick;* lift griffe G with uprights E selected according to the pattern and 'red' board I, insert red weft. Result—one pick of plain red cloth on the *face*, where part of hooks E are down, but where the other part of hooks E are lifted, this pick will weave plain red at the *back* of the cloth. See Fig. 231; the dots indicate the red and the circles the olive warp.

Second pick; lift griffe H and 'olive' board III, insert an olive weft. Result—one pick of plain olive cloth on the *face*, where part of hooks F are down, but where the other part of hooks F are lifted, this pick will weave plain olive at the *back* of the cloth. See Fig. 232.

Card 2. *Third pick;* lift griffe G and 'red' board II, insert red weft. Result—the same as the first pick except the weft is in the opposite shed. See Fig. 233.

Fourth pick; lift griffe F and 'olive' board IV, insert olive weft. Result—the same as the second pick except the weft is in the opposite shed. See Fig. 234.

The Ingrain Loom.

There are numerous makes of these looms, the distinguishing features of which are the jacquard shedding and the shuttle box mechanisms combined with the 'pick and pick at will' motion. Other details such as letting off the warp and taking up the carpet by positive arrangements, are illustrated and explained in the following pages all the illustrations for which have been prepared from the 'Crompton & Knowles' American Loom as made by Messrs. Hutchinson & Hollingworth, Dobcross, England. A consideration of the foregoing will explain all the essential principles involved in weaving these carpets.

Driving the Loom. The method adopted is compound; it consists of first imparting a fast rotary motion to a short supplementary shaft placed at right angles to the

crank and low shafts, the required reduced speed of the loom being obtained through bevel gearing to the bottom shaft.

Fig. 235 represents an elevation of the above system of driving as seen from the driving end of the loom. A and B are fast and loose pulleys respectively, on the supplementary shaft C. A small bevel wheel D secured to the opposite end of shaft C gears into and drives a larger bevel wheel E, keyed fast to one end of the low shaft F. Behind the bevel E and fastened on the same shaft F is a spur wheel G which gears into a second spur wheel H securely keyed to the crank shaft J. It will therefore be observed that the crank shaft receives its motion from the low shaft which is the reverse of common practice. The primary object of this arrangement is to impart a variable velocity to the 'lay' by setting the two wheels G and H out of centre. Afterwards these two wheels are so placed on their respective shafts that the smallest diameter of the wheel G gears into the largest diameter of the wheel H; then as the two shafts simultaneously revolve these conditions are gradually reversed until the greatest diameter of the driving wheel G is in gear with the smallest diameter of the driven wheel H. Thus the crank shaft is made to revolve with a variable velocity and to make its slowest speed when the smallest diameter of G is in gear with the largest diameter of H, during which time the crank is at its 'back centre' and the shuttle is passing through the shed. When the crank shaft J has reached its 'front centre,' the largest diameter of G is in gear with the smallest diameter of H and the crank is then travelling quickest and during this time it is beating the weft into the carpet. This eccentric system is mostly required in looms of wide width.

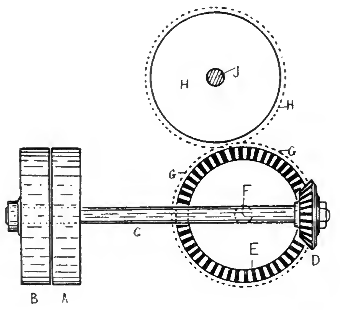


Fig. 235.

Jacquard Shedding— Full Harness Mounting.

The extensive variety of the modern Ingrain carpet involves the application of a full harness mounting and frequently of a cross border jacquard. For 4/4 widths a jacquard having a capacity of 400 or 600 uprights is frequently equal to the variety of figure required, but for 3 × 3 yards art squares, of which very many are made, a good cross border machine is a desideratum.

The single lift jacquard which sheds from the bottom, the double lift jacquard producing a semi-open shed and the "centre shed" jacquard are all extensively employed, but the construction of these being well known, a detailed description is perforce unnecessary. It might be pointed out at this juncture that the harness cords are frequently tied up on the "London" system, *i.e.*, the jacquard is placed at right angles to the comberboard and the cards and card cylinder work at the right or left hand side of the loom, in contradistinction from the "Norwich" principle where the jacquard machine is parallel with the comberboard and the card cylinder operates at the back of the loom. Incidentally, it might also be stated here, that there are three fundamental systems of tieing up the harness cords to the upright lifting hooks of a jacquard machine viz :—

1. The '*Single tie*,' which is only required when there is no repetition of any of the pattern. One harness cord only is tied up to the hook of the jacquard and there must be as many hooks as there are threads of warp. The cords are tied to the jacquard hooks and taken down through the comberboard in regular order from first to last consecutively. The warp threads are successively drawn through the mails of the harness in the same order.
2. The '*Repeating tie*.' This is the commonest tie and is used for all figure designs which contain more than one repeat of pattern in the full width of the carpet.
3. The '*Centre tie*.' This method is used when the two halves of any figure or border are alike when turned over. In all such cases a repeat of the pattern only requires half the number of hooks to complete it.

These three ties represent the possibilities of all other combinations.

Cross Border Jacquard.

Fig. 236 shows a vertical section of a 12 row 600 jacquard machine patented and used on this Ingrain loom. There are two card cylinders A and A¹; the former controls the body and the filling whilst the

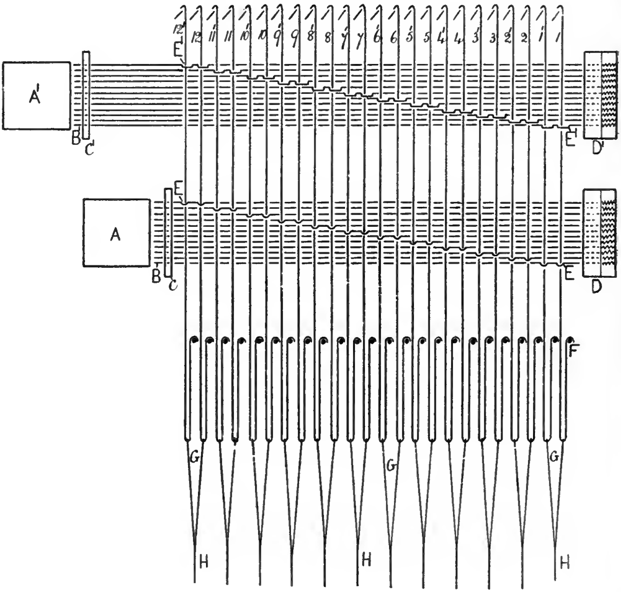


Fig. 236.

latter operates to produce the cross border and corners. C and C¹ represent the needle boards, B and B¹ the needles or cross wires and D and D¹ the spring boxes. There are two uprights and neckbands G to each repeat of the harness cords H as in the ordinary double lift machine. Each needle in both the top and bottom set is connected with two hooks as shown. The lower set controls

the uprights by a small loop E as is common but the upper set is formed with a long loop E^1, the object being to permit the bottom set of needles to press the hooks off the griffe lifting bars independently of the top set, under which circumstances the jacquard can be used as an ordinary double lift. Where a cross border machine is available the cards can be cut and worked according to the plan described on page 151.

Shuttle Box Mechanism— Odd Pick.

In the production of woven fabrics where only one sort or colour of weft is required, one shuttle supplied with weft and propelled alternately from opposite sides of the loom through successive divisions of the warp threads satisfies all the wefting requirements.

The term 'plain loom' is usually applied to those which are constructed for the use of one shuttle only. To each end of the 'going part' a single box is made for the reception of the shuttle. Each box usually consists of a bottom, front, back and one closed end with an open top and a free entrance.

When it is required to produce woven fabrics having two or more colours or sorts of yarn, the use of additional shuttles becomes a necessity. Provision must therefore be made to temporarily and suitably store those shuttles which contain the kind of weft indicated by the pattern, but not required at the particular moment.

When the number of picks of any given colour are of even quantity *i.e.* two picks or any multiple of two, then it is only necessary to store the shuttles at one end of the loom, one side being exactly the same as that employed for a 'plain' loom. The shuttle box mechanism for weaving such patterns is usually termed, 'even pick.' But whenever the pattern requires an odd number of picks of any given colour, which is almost always the case in Ingrains, it necessitates provision being made to conveniently store each shuttle at either end of the loom, for any required or suitable number of picks, and also 'picking' from either side of the loom for any successive but convenient number of shots. The mechanism employed in the production of woven fabrics belonging to this class is usually designated by the term 'odd pick' or 'pick and pick at will' box motion.

There are two chief systems of arrangement of boxes for weaving goods requiring two or more shuttles.

I. Rising Boxes.

II. Circular Boxes.

The Rising boxes consist chiefly of a set of steel plates or shelves supported in a vertical frame which move in a body so as to bring each or any to the same height and level as the race of the going part. The size of the shuttle boxes is governed by the dimensions of the shuttle to be used which in turn is determined by the class of goods to be made, some involving a 'deep' and others a 'small' shed. For slow running looms and for heavy goods the drop box arrangement is generally adopted, since it possesses the advantage of rising or falling two or three boxes with less difficulty than by 'skipping' as on the Circular system.

Driving the semi-toothed cylinders and the pattern box chain.

Fig. 237 shows a sectional elevation of the mechanism designed to drive the two semi-toothed cylinders 1 and 2 together with the pattern chain for controlling the shuttle boxes.

The crank shaft J contains a pinion wheel K which gears into and rotates a spur wheel L compounded with a bevel M and carried on stud N supported in the loom framing; the bevel M meshes with a second bevel O at the base and loose upon the upright shaft P; the bevel O forms part of a clutch box of which Q and R make up the complement; Q is a disc secured by a set screw to the shaft P; R is another disc also loose upon the shaft P; it carries a pin R^1 which passes through a hole R^2 of similar diameter in the disc Q and bevel O to combine these parts and drive the shaft P.

Into the neck formed in the sleeve of R, the forked end of a hand lever S fits, by which arrangement the upper parts of the clutch box Q and R are disconnected at will; by this means the loom can be worked independently of the box motions and conversely the boxes can be operated in either direction, irrespective of the other loom parts.

Near the upper end of shaft P a bevel T gears into and drives a bevel U, fast to the end of the bottom segment toothed cylinder 2 to depress the boxes. An additional bevel wheel V combines with a

bevel wheel W, on the boss or barrel of the top segment toothed cylinder to elevate the boxes. A double clutch X is fast rotatively to the shaft Y but free to slide laterally upon it to the right or left. Loose upon the shaft Y is a second bevel Z which also combines in gear with the driving bevel V. The clutch X may be locked with either bevels W or Z to rotate the shaft Y in either direction. A neck

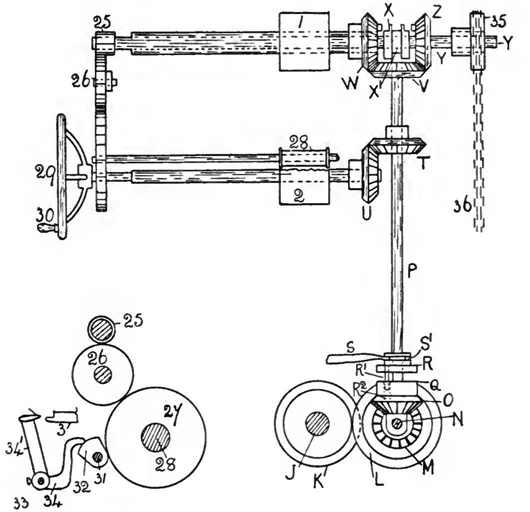


Fig. 238. Fig. 237.

or recess X^1 is circumscribed about the periphery of the clutch X, into which a fork fits being controlled by a rod and hand lever. The solid shaft Y passes freely through the barrel of cylinder 1 and carries a spur pinion 25 which communicates motion to an intermediate spur wheel 26, and to a large spur wheel 27 fast on one end of the bowl or pattern cylinder 28. See Fig. 238.

The vibrator gears 5 may be brought into operative contact with either of the constantly rotating toothed cylinder 1 or 2. A bowl P lifts lever 3 or its duplicate into contact with cylinder 1 for raising

the boxes and conversely a ferrel allows the vibrator lever 3 or its duplicates to fall into gear with the cylinder 2 for depressing the boxes.

Six "Decker" Rising Boxes.

Fig. 239 shows a front elevation of the essential parts of the mechanism employed with six rising and falling shuttle boxes at each end of the loom.

The semi-toothed cylinders 1 and 2 revolve in opposite directions with a constant rotation; the former serves to elevate the boxes and the latter to depress them. A vibrator lever 3 fulcrumed at 4 supports a toothed gear 5 which is minus one tooth at *a* and four

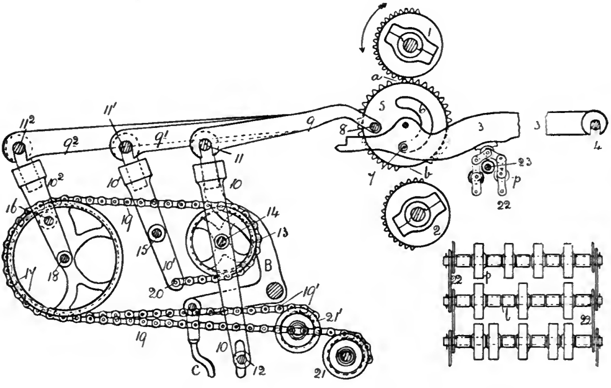


Fig. 239. Fig. 240.

teeth at *b*; it has also a semi slot 6 formed in it through which a fixed rod 7 passes to prevent it from over-running. A loose pin 8 passes through one end of a connecting link 9 and the gear 5; the link 9 joins the vibrator gear to a simple lever 10 at the point 11; the lever 10 is pivoted upon a stud 12 and carries a chain pulley 13 centrally located and free to rotate upon the stud 14. Links 9^1 and 9^2 connect the chain levers 10^1 and 10^2 to individual vibrator gears which correspond with that shown at 5 and are similarly operated. Lever 10^1 has its fulcrum at 15; its two arms are in the ratio of 2 to 1. Lever 10^2 is pivoted on the stud 16

and carries a chain wheel 17, free to rotate on the stud 18. The chain 19 is fastened to the bottom of lever 10^1 at the point 20 and then passes round the pulleys 13, 17 and 21 to an upright spindle on which the boxes are supported and free to be lifted by the chain on one side of the loom—in this case the right hand side. The duplicate chain 19^1 is joined to duplicate levers and vibrator gears corresponding with those just described and then passes over guide pulley 21^1 to the opposite side of the loom to operate the boxes there. The vibrator lever 3 is operated upon by a roller chain 22, see Fig. 240, which is carried forward by means of a constantly rotating pattern or box chain cylinder 23 or 28. The pattern chain as at 22 consists of small bowl pulleys *p* and ferrels *f*. A bowl lifts the lever 3 with its vibrator gear 5 into combination with the top cylinder 1 to be rotated by it for one half of a revolution, until the opposite end of the slot 6 is brought into close contact with spindle rod 7 and as often as a bowl is brought up by the chain to keep the lever 3 up, so long will the vibrator 5 remain in the above position but immediately a ferrel *f* is brought forward by the pattern chain, the lever 3 with the vibrator gear drops into and meshes with the teeth in the bottom semi-toothed cylinder 2 and thereby turns it back into the position shown in the diagram, by which means the lever 9 and link 10 travel to the left and thereby release the pressure and pull on the 'lifting' chain to lower the boxes either positively or negatively by their own weight assisted by a strong spiral spring. The action of the vibrator on link 9^1 and lever 10^1 is sufficient to produce a rise of one box, since this lever pulls directly upon the chain 19. The levers 10 and 10^2 acting through their respective pulleys produce a rise of two boxes each. Hence by a judicious combination of these, any box can be brought up to the level of the shuttle race.

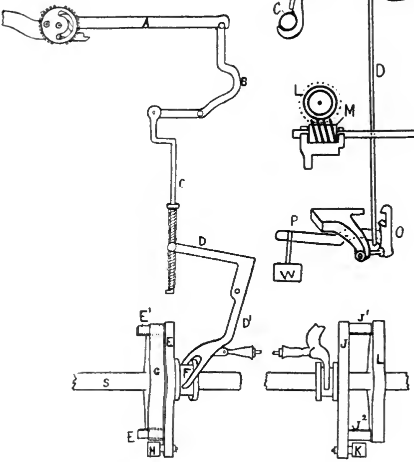
Picking—"Odd Pick."

Combined with the shuttle box mechanism is the picking motion, designed to pick and pick at will, from either side of loom. Fig. 241 shows an elevation of such an arrangement as viewed from the back of the loom.

The connecting link A joins the vibrator gear with a bent lever B pivoted on a stud as shown. A vertical rod C combines the lever B

with the lever arm D which is free to oscillate upon the stud near the sign D[1] representing the lower arm which is fork shaped at its base and fits into the neck F of a clutch part E, fast rotatively, but free to slide laterally upon the low shaft S. The second part of the clutch, shown at G is keyed fast to the bottom shaft S; at each end of G a recess is formed into which two prongs E^1 and E^2 fit and are free to slide. These prongs project from and are firmly fixed in

Fig. 241.



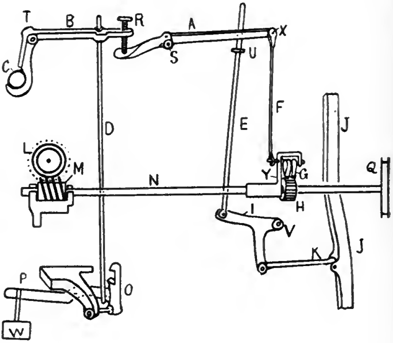


Fig. 242.

clutch part E one end of which carries a stud and antifriction bowl H, which, when in the position shown, strikes a picking 'shoe' carried on a picking shaft placed horizontally and near the foot of the loom and supported loosely in bearings at right angles to the bottom shaft S. The picking stick is connected directly with the picking shaft so that whenever the picking 'shoe' is struck by the rotating bowl H it is forced downwards and by its connections the picking stick is thrown forward to exert the required force upon the shuttle and propel it from side to side of the loom.

A connecting rod links duplicate mechanism on the opposite sides of the loom as shown at J J^1 J^2 K and L which respectively coincide with the parts E E^1 E^2 H and G. The arrangement is such that when bowl H is in striking range of the tappet, that of K is pulled clear and vice versa. This is obtained through the action of the rotating segment toothed cylinders on the vibrator gear as follows:—A pulley *p* on the pattern chain 22 elevates the vibrator lever which gears in combination with the top cylinder to turn the gear half a revolution, pull connecting arm A to the left, rotate lever B counter-clockwise and lever D and D^1 clockwise so that the fork operates upon neck F and pulls the part clutch E to the right until bowl H is clear of its respective picking shoe, whilst the duplicate parts at the opposite side of the loom are pressed into operative action so that the bowl K is in position to strike the picking shoe at the left hand side of the loom. Conversely if a ferrel is brought into contact with the vibrator gear the pick will be delivered from the right hand side of the loom.

Letting off the Warp —Positive.

Fig. 242 is a sectional elevation of the warp controlling motion. The view of the elevation is from the inside of the loom. A is a simple lever having a long and short arm free to move about the stud S, which is securely fastened to the loom end. B is a bell crank lever and free to move upon the stud T, also fastened to the loom framing. The almost vertical arm of this lever is recessed so as to support a steel beam C, over which the warp passes from the warp beams to the healds and carpet. The straight arm of this lever B supports an adjustable connecting rod D and also a regulating screw R; the vertical straight rod D connects the lever B with the arm P, the latter being the weight lever having its fulcrum at the point O. The rod E, connected to the bell crank lever I, is free to move in a vertical direction. An adjustable collar U is fixed to the rod E just below the lever A, as shown. The bell crank lever A is supported and free to move upon the stud V, fixed to the loom framing. A small connecting rod K unites the lever I with the lower part of the sword of the going part J. A fourth connecting rod F is suspended from the lever A at the point X.

The lower end of this rod supports a casting Y which contains two small pawls or pushing catches G. The casting Y is free to rotate upon the horizontal shaft N. Upon this same shaft a ratchet wheel H is securely fastened. The shaft N also contains at opposite ends a small brake wheel Q and a worm M respectively, both of which are keyed and turn with the shaft. The worm M gears into a worm wheel L, which latter is securely keyed to the end of the warp beam.

The process of unwinding the warp and the action of the above several parts are as follows: The warp passes from the warp beam over the steel roller support C to the fell of the carpet. Each time the going part strikes against the fell of the fabric it causes the warp to exert a force upon the roller C, which, being fixed in the upright arm of the lever B, tends to press it inwards; but to elevate the horizontal arm the latter is regulated by the resistance of the weight W and the lever P acting through the connecting rod D. The adjustable screw R rises slightly with the horizontal arm of lever B, and thus leaves room for the short arm of lever A to rise until it is in contact with screw R. Also when the going part travels towards the fell of the cloth, the connecting rod K pulls forward the lower arm of the lever I, and thus permits the upper arm connecting rod E with collar U to fall. The long arm of the lever A is free to fall part way towards U, but it cannot fall to the lowest point to which the collar U descends, because the short arm of A comes in contact with the screw R, and so regulates the distance which the connecting rod E with the casting Y falls on the remote side of the shaft N. Consequently the pawls G are permitted to recede ½, 1, 2, 3, or more teeth in the ratchet wheel, according as the take-up of the cloth requires. Then as the going part recedes, the strain is released from the back roller C, which therefore allows the force acting through the connecting rod D upon the horizontal arm of the lever B to cause screw R to press upon the short arm of lever A, thus tending to elevate the longer arm, rod F, casting Y, and pawls G. At the same time, as the going part recedes, the connecting rod K pushes back the lower arm of lever I, and elevates the upper arm with the rod E and collar U, the last of which presses against the underside of the longer arm of lever A and thus assists in

raising rod E, casting Y and pawls G. Hence ratchet wheel H, shaft N, worm M, are slowly but gradually turned upon the shaft bearings, and since the worm M gears into the worm wheel L upon the warp beam, this beam is positively turned and unwinds the warp according to the take-up of the carpet and the pressure of the warp upon the back rest C, which for the same make of fabric should always remain constant. Consequently there is scarcely any necessity to change the weights and levers from a full to an empty warp beam.

Taking up—Positive.

The initial motion to this mechanism is derived from the top segment cylinder Fig. 237. Upon the end of shaft Y is secured a chain wheel 35 which rotates a chain 36 passing round a second chain wheel 37, Fig. 243,

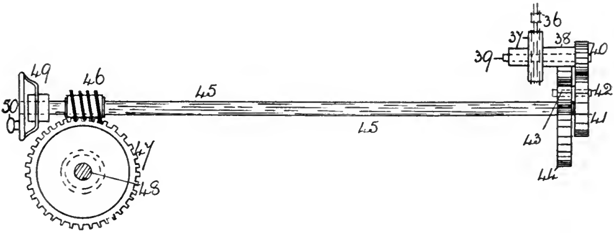


Fig. 243.

made fast to the remote end of a barrel shaft 38 mounted loosely upon stud, 39. The barrel 38 has spur teeth, 40, around its periphery and these gear into the teeth of an intermediate wheel, 41, free to rotate on stud 42. Compounded with wheel 41 is a smaller intermediate wheel 43 whose teeth mesh with and drive a large spur wheel 44, mounted rotatively upon a cross shaft 45 which reaches across the loom frame from back to front and is contained on the outside. At the opposite end of shaft 45 is secured a worm 46 which gears into and drives a large worm wheel 47 fastened firmly to the end of the "perforated" roller 48 which takes up the cloth positively through the rotative action of the above train of wheels.

ESTABLISHED 1852.

WILSON & CO. BARNSLEY Ltd.,

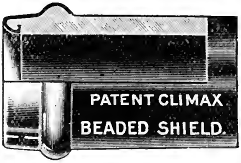
BARNSLEY.

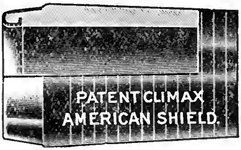
Nat. Tel.: No. 2, Barnsley. Cable or Telegrams: 'WILSON, BARNSLEY.'
A1 and A B C Codes used.

Attendance—Manchester Royal Exchange, Tuesday and Friday.
Bradford Exchange, Monday & Friday. Huddersfield Exchange, Tuesday.
Manchester Office:—15, Market Street.

Manufacture every description of "Improved and Shielded Bobbin," used in the Spinning and Manufacture of Cotton, Wool, Silk and other textiles.

Added Strength and absolute Security.





Absolutely secure combination of Shield and Bobbin guaranteed.

Loose Shields impcssible.

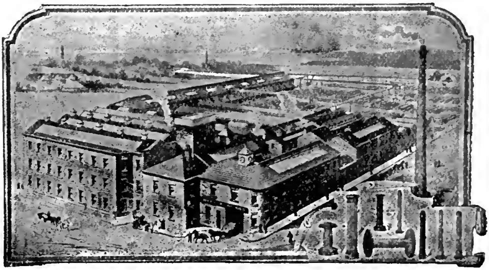
SPECIALITIES:

Patentees & Sole Makers of 'LOCKFAST' and 'CLIMAX' Shields.

Every Shield or Cap guaranteed absolutely and permanently fast.

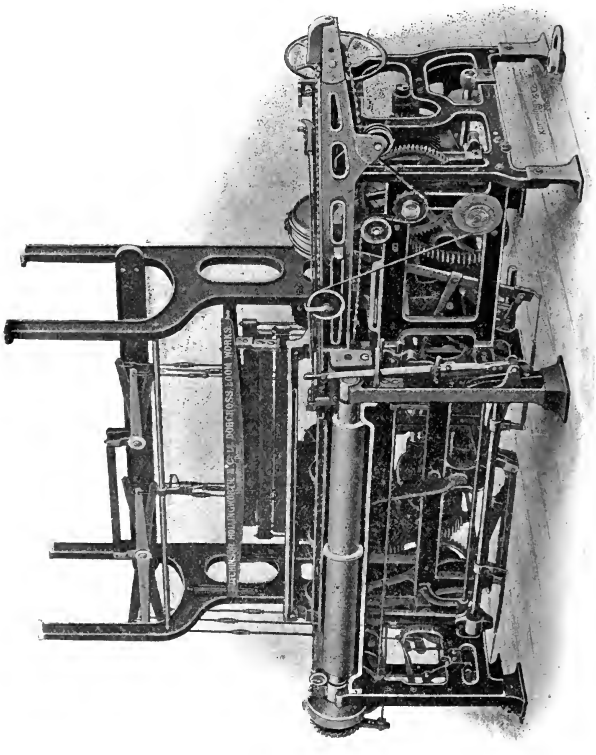
ENAMELLED CONDITIONING BOBBINS, Impervious to Steam, Moisture, or Oil.

Samples and Prices on application to the Head Offices and Works, BARNSLEY.



THE	INGRAIN LOOM.	See page	xvi.
,,	6/4 BRUSSELS.	,, ,,	xvii.
,,	AXMINSTER.	,, ,,	xviii.
,,	3/4 BRUSSELS.	,, ,,	xix.

See page xv.



6/4 Brussels Loom.

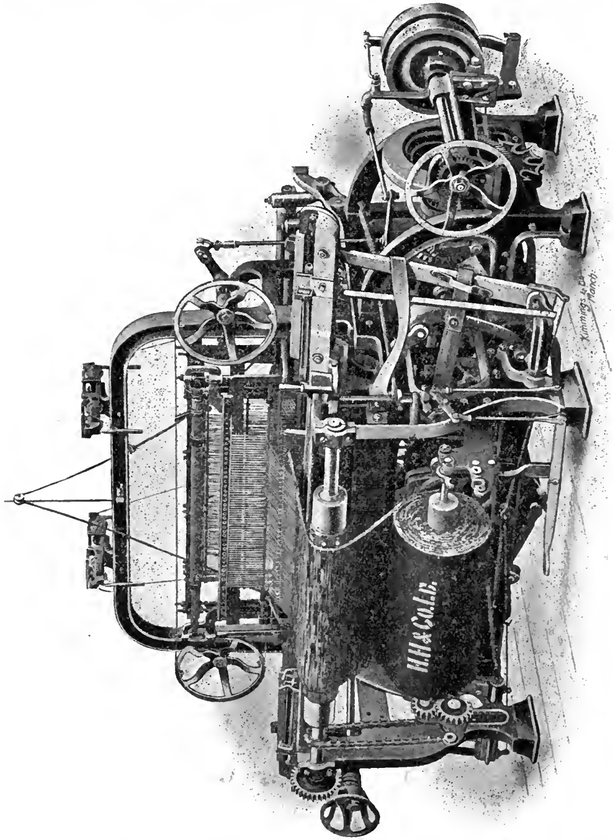
HUTCHINSON, HOLLINGWORTH & CO., Ltd.,

DOBCROSS LOOM WORKS,

DOBCROSS, Via Oldham, England.

Makers of Looms for Weaving all kinds of Worsteds, Woollens, Carpets, etc.

Telegrams: "Foundry, Dobcross." **Railway Station: Saddleworth, L. & N.W.** **Telephone No. 10, Marsden Exchange**



AXMINSTER LOOM.

THE HOLLINGWORTH PATENT CHENILLE AXMINSTER LOOM

For weaving goods up to 40″ wide, fitted with patent special motions for stopping the Loom during the placing in and adjusting of the chenille weft, With powerful **Take-up and Let-off Motions, Special Driving Arrangement, etc.,** and embodying all the latest improvements for weaving this class of fabric.

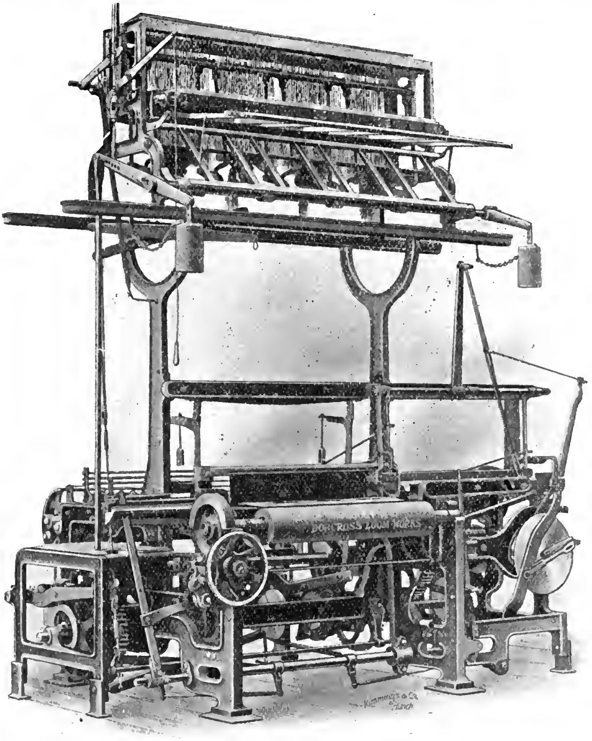
HUTCHINSON, HOLLINGWORTH & CO., Ltd.,

DOBCROSS LOOM WORKS,

DOBCROSS, Via Oldham, England.

Makers of Looms for Weaving all kinds of Worsteds, Woollens, Carpets, etc.

Telegrams: "Foundry, Dobcross." Railway Station: Saddleworth, L. & N.W. Telephone No. 10, Marsden Exchange



BRUSSELS LOOM.

BRUSSELS AND BRUSSELS VELVET (Wilton) CARPET LOOM,

Two or three shot, embodying Hollingworths' Patents in all widths from $\frac{2}{4}$ up to $\frac{6}{4}$ wide, with **various kinds of wire motions,** and furnished with either **5 frame, 6 frame, or 5 and 6 frame Jacquard Machines,** with powerful **double beat lay motions, take-up or letting-ff motions, and driving motions,** and embodying all the latest improvements for weaving this class of goods. In all respects **a strong loom** and suitable for heavy work. Also Makers of **Tapestry, Tapestry Velvet,** and **Tapestry Velvet Table Cover Looms,** in various widths.

[illegible] 23

[illegible] 32